SPATIAL DISTRIBUTION AND UTILIZATION OF ELECTRICITY TRANSFORMER IN SABON GARI LOCAL GOVERNMENT AREA ZARIA, KADUNA STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA, IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE AWARD THE DEGREE OF MASTERS OF SCIENCE IN REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

DEPARTMENT OF GEOGRAPHY,

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DECEMBER, 2015

DECLARATION

I hereby declare that this thesis was written by me and that it is a record of my own research work. I declare that this research work has not been submitted in any form whether partly or whole for any degree at any level known to me. All sources of publication and related reports cited in the investigation have been identified and referenced accordingly.

CHATTA, Grace Ozohu ……. ……

Name Signature Date

CERTIFICATION PAGE

This thesis titled, "**Spatial Distribution and Utilization of Electricity Transformer in Sabon Gari Local Government Area Zaria Kaduna State, Nigeria**", was written by CHATTA Ozohu Grace, meets the regulations that govern the award of Masters Degree of Geography in Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to God the Almighty, my father (late) Mr. James Chatta, and my mother Mrs. Elizabeth Chatta, who laid the foundation of my education and for all the support and sacrifices. May God Almighty bless and prosper you.

ACKNOWLEDGEMENTS

I the researcher wishes to express my profound gratitude to God Almighty who has made it possible for me to come thus far in life and to even undertake this Msc programme and finish successfully.

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My appreciation also goes to my parents for supporting me financially. I extend my regards to the people of Sabo Gari Local Government Area, Kaduna State, Nigeria and PHCN staff who provided me with data required for the study and their cooperation during data collection.

Furthermore, regards goes to my siblings Charles Chatta, Emmanuel Chatta and Mary Chatta also to Dr Adedokun, Mr Olusegun Oki, Pst Edwin Eninoboh, Stanley Onyemelukwe, Pastor and Mrs Bishut, Mr and Mrs Maliki, Mr and Mrs Dominic, Mrs Osumeje, the entire staff of Kingdom Heritage Model School Zaria. And my course mate Msc GIS/ Remote Sensing.

ABSTRACT

This study examined the spatial distribution and utilization of electricity transformer in Sabon Gari local government area in Zaria Kaduna state. The aim of the study was to examine the distribution of Electric transformers and their utilization level in Sabon Gari LGA Zaria. The objectives were to; identify and map out the spatial location of transformers, build a spatial database of the transformers, examine the conditions of the transformers and explain the level of utilization of the transformers in the study area. A purposive sampling technique was used to select the study area as well as the respondents. A total of 361 copies of structured questionnaire were administered to the residents in the study area, while 50 copies of questionnaire were administered to the PHCN Staff at the 3 distribution units (i.e. Samaru, Dogarawa and Pz) in the study area, out of which 361 and 50 copies of questionnaires were adequately filled and returned from the residents and PHCN Staff respectively. The results are presented using tables. The results indicated that 40% of Public owned transformers are found in both Samaru and Dogarawa area each, while the rest (20%) is found in Pz area. Also, private owned transformer 30% of the transformers are found in Samaru area, 14% in Dogarawa and about 56% in PZ where there are more banks and companies. In terms of the capacity level of the transformer, 40.0% accounted for 50KVA which is the lowest capacity level of the transformer while 70.0% accounted for 500KVA which is the highest capacity level of transformers in the study area. Finding on the conditions of public transformers revealed that majority (80.0%) of the transformers need repair while the rest (20.0%) needs to be change. About 100% of the private transformers in the study are in good condition. The result on the response of respondents on power supply hours show that most of the respondents (67.31%) reported that they have power supply for 12 hours, while only a few (2.22%) reported that they have power supply for 24 hours

every day. In conclusion, to ensure effective distribution and utilization of electricity transformer, illegal connection should be discouraged by the stakeholders. PHCN's management should develop a maintenance culture whereby the equipment are checked more regularly rather than waiting for the equipment to finally breakdown. They should also continue to upgrade their equipments in order to meet up with the demand of customers. There is the need for Federal Government to inject more funds into the power sector to enable them get more transformers to reduce overloads on the few existing ones.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

The Electric power sector is one of the most important sectors to national development. It is also critical to the developmental reform of any country. The Power Holding Company of Nigeria (PHCN) formerly known as the National Electric Power Authority (NEPA) is an organization involved in the supply of electricity in Nigeria and presently due to privatization of the power sector, Kaduna state now has an electricity distribution power body called Kaduna Electricity Distribution Company (KEDCO). The power sector plays a very important role in the economic development of a nation; therefore, the growth of industries, agriculture, infrastructure, and the private sector is dependent on the state of the power sector.

In Nigeria, the Power Holding Company of Nigeria (PHCN) is the public utility company saddled with the task of managing the power sector. PHCN was established in 1972 with a mandate to maintain an efficient system of electric supply to all parts of the Nigeria. After NEPA was renamed PHCN, the government also unbundled 18 successor companies from the PHCN – six generation companies; one transmission company and 11 distribution companies. These networks are made up of wires, pipes, transformers, valves, meters and poles and these networks needs to be managed by a complex database in order to censure effectiveness of operation (Williams, 2010).

The importance of electric power supply cannot be overemphasized as it is considered the most important commodity for national development. With electrical energy, people are empowered to work from the domestic level and the cottage industries, through the small-scale and medium industries to employment in the large-scale manufacturing complexes. In these days, depriving people of electric power is tantamount to castration (Musa, 2009).

Electric power is the engine that drives industrialization, which improves communication, helps innovation in science and Technology, provides sound healthcare delivery system and improves citizen's standard of living. Since electric power is the engine that drives industrialization, a stable supply is the key for Nigeria to become one of the 20 developed economies in the world. However, it is unfortunate that the biggest problem in Nigeria is electricity crisis, a crisis without end. It was also revealed that the total grid capacity of 8,876 MW with only 3,653 MW available as at December 2009. Thus available power was less than 41% of the total installed capacity. Some of the other problems identified included among others corruption, poor maintenance, mismanagement, inadequate funding and lack of energy remix. It is worth to note that the appalling levels of the nation's infrastructure, namely power supply, water, telecommunication and even , petroleum product supply are all indication of an economy that is unhealthy as a result of PHCN's inability to meet electricity demand (Stanley, 2012).

Electricity is known worldwide except Nigeria as a versatile relatively cheap and cost effective means of providing energy in any nation or community. It consists of three main hierarchical stages or subsystems known respectively as generation, transmission and distribution. It is effective and indispensable machinery for the rapid industrial and economic growth of any nation. However, the electricity supply in Nigeria is characterized by frequent power failures and load shedding (Kareem, 2006).

Generally, electricity could be accepted to mean supply of electric current. This involves generation, transmission and distribution of the electric current to consumers. Electricity is an aspect of the utility sector that is very essential to the smooth and meaningful development of a society. It supports the economy and promotes the well-being of individuals. Efficient functioning of this utility is of paramount importance for the sustenance of its growth and consequential realization of its planning and managerial objectives (Emengini, 2004). Electrical

energy has become one of the most important things in people's life. This energy is supposed to be supplied to all houses and industries, although voltage fluctuation can cause problems but to avoid this kind of problem, electrical transformers are installed near the users. Transformer is a device which changes electric voltage from one circuit to another electric circuit through electromagnetic induction. These are for increasing or decreasing the voltage which comes from substation. There are many varieties of transformers which supply electricity to houses. They include custom current transformer, high transformer voltage, fly back transformer, electrical transformer, audio transformer, isolation transformer, step up and step down transformer and power transformer (Adetoro, 2002).

Generally the houses are supplied with electricity at limited amount of voltage(Adetoro, 2002). The voltage coming from power plant can be either high or low. These transformers are convenient, efficient and easy way of transferring electric energy to residential and commercial places. Electric power is used more efficiently than before and therefore, transformers help in transferring these powers to houses. These transformers can transfer power to far places in easy and efficient manner and they are also cost effective. Hence they have become a necessity in people's lives.

According to Arunagiri and Agarwal (2005) distributing transformers can also be fitted with meters so that loading of the transformers can be monitored on a real-time and the need for new transformers can be decided. This can be made visual by assigning a different color on the map for a transformer once it is overloaded hence giving a proper warning. Any aberration can be easily detected.

Transformers are not evenly distributed in Nigeria and as a result of that, the rate of theutilization of eachone may be high. Due to the fact that a lot of houses use just one transformer which will in turn make the transformers to develop problems and at the end even

pack up. An example is the case where there is one transformer servingmany houses beyond itscapacity that transformer may pack up due to the excess load its carrying.

However, there has been series of new reforms in the power sectors across the country in general with Kaduna state inclusive. On November 1, 2013, the Federal Government, through the BPE handed over the assets of the assets of PHCN to the private investors, after the conclusion of the privatization process. With the successful handover of the assets to the private sector, there were high hopes that electricity supply would show unprecedented improvement, but exactly 14 months after the handover of the assets, it is still the same old story but as of now the power sector has improved. Before President Goodluck Jonathan's administration, efforts to reform the power sector did not succeed in raising outputs or laying the requisite foundation for sustainable improvements in power generation, transmission and distribution. However, the power sector reforms embarked on by President Jonathan's administration have laid the foundation for sustainable improvement with promising results (Guzomakem, 2015).

In the Northwest, power sector reforms are improving reliability of and access to electricity with a total installed generation capacity increase from about 8,500 MW before President Goodluck Jonathan's administration to just under 10,000MW now, while average installed capacity has nearly doubled as a result of the reforms and when completed, the Galma Hydro Power Station in Kaduna generated 2.5 megawatts of electricity (Guzomakem, 2015). The Northwest has recorded a reduction in the proportion of households experiencing frequent blackouts from 43% to 18%. System reliability has also improved significantly during the President Jonathan's administration; with a total number of power system collapse decrease from 22% before the reforms to 15% currently. Moreso, power distribution to the Northwest at 33/11 MVA after the reforms was up by 22 from 368 for the Kaduna Disco and from 397 to 483 in Kano. This has been made possible by increased allocation of electricity to the two distribution

companies in the Northwest, Kaduna Disco and Kano Disco. In addition, access to electricity has significantly improved from 36.6% before the administration came into office to 42.2% as at 2013 (Guzomakem, 2015).

In an overview of power sector challenges in the northwestern zone in general and Kaduna state in particular before the recent reforms in the sector under Goodluck administration, Sule (2015) highlighted that the poor power supply in the country was caused by multiple challenges hampering generation and distribution of electricity. Going further, Abdullahi, the KEDCO Head of Corporate Communication (Kaduna Electricity Distribution Company (KEDCO) a public utility company which is saddled with the responsibility of generation, transmission, distribution and marketing of electric power in the northwestern zone of Nigeria) was cited by Sule (2015) in a report on Daily Trust (Feb, 20/2015) that the major challenges against effective distribution of power. According to the report, the first is the issue of generation; the generating companies have not been able to produce sufficient power that can serve the whole of the country, with the total daily power generation capacity requirement for the zone of Kaduna, Sokoto, Zamfara and Kebbi in the range of about 700 megawatts to 800 Megawatts. In reality, only between 150MW to 200MW are generated for the entire region, which is not even enough to serve Kaduna, let alone the other states. Also, in the same report, it was pointed out that the infrastructures such as transformers, the power lines and the sub-stations are very weak, with some installed way back in the 70s and 80s and they have not undergone any major refurbishment since then. The reported pointed that unless these major challenges are resolved, the generating companies will not be able to provide power beyond the current capacity. Abdullahi, however, stated further that plans were underway to refurbish and rehabilitate the facilities to make them more modern and until that is done infrastructure challenges will continue to hamper effective distribution. Heavy rain falls for instance, affect

electric poles because of their weak status; they are easily destroyed by rainstorm. It was also emphasized in the report that rationing of power allocation had adversely affected industrial and other economic activities, especially in states under the company. The small scale businesses are finding it difficult to survive because of the poor electricity supply and the very big ones are having difficulties in having alternative sources of power supply. The negative impact on the economy will continue until more energy that can carter for the entire zone is made available, otherwise the businesses will continue to struggle especially the small scale businesses.

Sule (2015) also reported that the distribution areas in Kaduna, Kebbi and Sokoto and Kebbi have been completed but are yet to be commissioned and once commissioned they will add to what the states are receiving from the distribution company and that will boost power supply in the zone. On decentralization of power distribution, it was reported that there was nothing wrong with the current arrangement. The reporter went ahead to state that the unbundling of the power sector by the Federal Government was done in good fate, "even though it cannot be said to be 100 per cent successful", but the idea of bringing private investors into the sector is a good step in the right direction and will move the sector forward as it is the standard practice all over the world, as all developed countries involve the private sector in power management (Abdullahi, 2015).

With regards to the above highlighted challenges facing power sectors as well as the current reforms aimed at mitigating the challenges. This study therefore can be considered timely and relevant as it is meant to improve the understanding of electricity power distribution and utilization towards effective power supply. Most importantly, it will help the power industry to keep track of the electrical facilities (transformers) involved in the delivery of energy to the end-users. This will be made possible with the aid of GIS, as variety of information can be better organized on a computer system linking the database to an output map and can effectively be

used to manage and monitor information on the distribution of electricity to end-users including information describing their spatial and non-spatial attributes such as geographical location and electricity use.

1.2 STATEMENT OF THE PROBLEM

The absence of up-to-date information about the facilities of the Power Holding Company of Nigeria, Plc is a great hindrance towards delivering effective power supply to the people. No less than 38 electricity generating turbines are grounded in various power plants in the country (Emengini, 2004). These technically faulty gas turbines are unable to generate their required power output, thus compounding Nigeria's already poor electricity supply situation.

In recent decades, the Nigeriangovernment has been given all manner of excuses for the recent drop in electricity supply despite assurances of improvement, but investigations have shown that it will take even a while longer before the country can experience some reprieve. This is because virtually all the generation plants are bugged down with one technical problem or the other.

The reality is such that even if the Federal Government fulfils its pledge to revamp these faulty plants, Nigerians will still not have enough power to meet their industrial and domestic energy needs. This statement was made by Clara in (Vanguard Newspaper, 2010 Vol 13 No 4).In Lagos state which is Nigeria's commercial nerve centre, is estimated to require between 10,000 and 12,000 megawatts, MWs, whereas is only able to get a paltry 928MWs, out of the 3,714MWs generated, while Abuja receives a mere 44.2MW (Nwachukwu, 2009).

In recent times, the Federal Government of Nigeria (FGN) has been working hard to see to the realization of steady power supply in the country. The President made this clear when he gave a mandate to the Power Holding Company of Nigeria (PHCN) to ensure uninterrupted power supply to the nation by 31st December 2010. It is noted that PHCN has raised electricity

output from as low as 1,600 megawatts to 4,000 megawatts and over one billion dollars spent in order to meet up with the mandate (Williams, 2010). Yet, erratic power supply and outages remain a major problem confronting the nation today. In this context, in as much as efforts are made towards efficient power generation, the subsequent transmission and distribution of the generated power should not be overlooked. Efficient functioning of the generated power cannot be achieved without proper record keeping and monitoring of the transmission and distribution network system.

A number of studies in the years were conducted on different aspects on power generation, distribution and facilities. For example According to Pickering (1993), any organization that expects to run an efficient day-to-day operation and to manage and develop its services effectively must know what asset it has, where they are, their condition, how they are performing, and how much it costs to provide the service.

Emengini (2004) noted that the knowledge about physical assets of the enterprise is necessary to make strategic and operation decisions. Thus, to take decisions vital to the operations, growth and management of electricity distribution facilities, information must be collected and analyzed to its full extent. Such information contributes not only to efficient services, but also to the operation and maintenance of assets, and to the sensible planning of extensions and new works. Also, poor electricity supply situation has turned almost every Nigerian into a self-styled generator with about N17.9 billion spent annually on imported generators to make up for electricity shortfall from the power suppliers (Okonedo, 2011).

Electricity distribution is the final stage in the delivery of electricity to end users. A distribution system's network carries electricity from the transmission system and delivers it to consumers. Typically, the network would include medium-voltage (less than 50 kilovolts) power lines, substations and pole-mounted transformers, low-voltage (less than 1 kilovolt) distribution

wiring and sometimes meters (Smith, 2005).Outages can be located faster even before the complaint from the consumer and maintenance crews can be immediately dispatched with critical information. Power thefts can also be identified and curbed. Installing meters on all incoming and outgoing feeders of transformers with real-time energy audits can do this.

Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used in powerstations, or to interconnect portions of powergrids. All operate on the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for household voltage. Transformers are essential for high-voltage electric power transmission, which makes long-distance transmission economically practical. Even in Kainji where the famous Kainji dam is located, PHCN has serious problems with the communities. The people of that area are protesting that PHCN is not a socially responsible company because they do not have sufficient light in the area and PHCN generate electricity from there. Although they help to generate power for Nigeria with their water resources, they are kept in darkness all the time (Ruben, 2008).

According to Manga (2012) there are two types of transformers that are being used in Sabon Gari Local Government Area (LGA). These transformers are the dedicated transformers and the Public transformers. The dedicated transformers are the transformers that are been used by personal companies like the banks and other big companies. These companies usually have their transformers in their own premises and these transformers are usually mounted. They usually have electricity most hours of the day. The owners take care of their transformers and because of the security they have in the companies like the banks the transformers cannot be stolen from the premises, while the public transformers are the transformers that are being used

by the public. They are installed in the public places on the ground and no security is assigned to watch over the transformer and as a result of that it can be easily stolen and tampered with. And also illegal connection can be done on it.

Previous researches have been carried out on electricity distribution in other areas of the country. For instance, Iyanda (1982) adopted the self-assessment methodology to estimate the impact of power shortages on the household sector. He focused on the high-income area of Lagos Island, Ikoyi, Victoria Island, Yaba and Surulere areas of Lagos state in Nigeria. He estimated an average electricity outage cost of N1.19 per hour for each household.

A similar framework of analysis was reported in Uchendu (1993), but the focus was on the industrial and commercial firms in Lagos state through a survey covering various industrial sectors. The study estimated several types of outage costs such as on material and equipment loss and value of unproduced output. The value of unproduced output was estimated at N1.3 million, N2.01 million and N1.32 million in 1991, 1992 and mid-1993, respectively. However, the study suffers from the methodological limitations of self-assessment data and was limited only to Lagos state.

World Bank (1993b) estimated the adaptive costs of electricity failure on the Nigerianeconomy at US$390 million, divided between consumer backup capacity (US$250million), operating and maintenance costs of diesel auto-generators (US$90 million), and fuel and lubrication (US$50 million). The estimate of NEPA revenue lost to unserved consumer energy amounted to US$40 million. However, the short-term losses incurred by consumers such as raw material and equipment spoilage and lost output were not estimated.

Finally, Lee and Anas (1991) used the self-assessment survey to measure the adaptive costs to the business sectors in coping with infrastructural deficiencies in Nigeria. Theirstudy shows that most firms in Nigeria adapt to the unreliability of publicly providedelectricity by

investing in backups. The huge investment costs of the backup increasesthe set-up costs of these firms and thus reduces their competitiveness and relativeefficiencies. One important finding of this study is that small firms have borne the bruntof power failure in Nigeria because they cannot afford personal generators. The studyshares the shortcomings of World Bank (1993b) in that the short-term losses incurred byconsumers arising from raw material and equipment spoilage and lost output were notestimated.

In view of the above previous studies, it is clear that they all focused in measuring the cost of electric power shortages in Nigeriabut none to the best of my knowledge have been carried out on the spatial distribution and utilization of electricity transformers in SabonGari LGA. This is the reason why this research on the spatial distribution and utilization of electricity transformers is been carried out, with a view to determine their efficiency and optimality.

1.3 RESEARCH QUESTIONS

The research questions of the study are:

i. Where are the transformers located in the study area?
ii. How many houses does the transformer service?
iii. What are the conditions of the transformers?
iv. How are the transformers utilized?

1.4 AIM AND OBJECTIVES OF THE STUDY

The aim of the study is to examine the distribution of Electric transformers and their utilization level in Sabon Gari LGA Zaria. This will be achieved through the following set of objectives to:

i. identify and map out the spatial location of transformers.

ii. build a spatial database of the transformers.

iii. examine the conditions of the transformers.

v. explain the level of utilization of the transformers

1.5 SCOPE OF THE STUDY

The scope of the study is limited only to areas in Sabon Gari L.G.A. The main sub-settlements that were selected for detailed analysis are Sabon Gari, Samaru, PZ, Kwangila and Hanwa all of which are under Sabon Gari L.G.A. Questionnaires were designed and administered to the residence in the selected areas of the LGA as well as to senior officials of PHCN Zaria unit to gather information on the nature of electricity supply and the number of service/functional transformers in the areas. The temporal scope of the study was 8 months in the year 2014.

1.6 JUSTIFICATION OF THE STUDY

The assessment of the spatial distribution of electricity transformers and its impact on power supply is very important in Nigeria. Access and utilization of this electricity infrastructure in Sabon Gari Local Government Area in Kaduna state has taken a declining trend over the years. Indeed there are a lot of electricity transformers all over the study area. Are they over utilized or are they underutilized? In many areas in Sabon Gari LGA there exist a lot of illegal connections of wires which have greatly affected the proper transmission of power to the appropriate areas and have consequently resulted to the loss of some transformers due to overloads. Also, it has led to loss of lives and properties.

This research is timely considering the high rate of illegal connection of electricity wires by residents and business people like the welders and the black market sellers of petrol who sell petrol at night in the study area. This study is therefore expected to serve as a way of proffering solution to the above problem. It will also enlighten the people in the study area on the effect of

over loading the transformers and the causes of over loading the transformers. It will go a long way on policy formulation on proper maintenance of the transformers by the PHCN staff and also the dangers of illegally connecting wires to high tension wires by residence. The database created as a result of this research will aid the PHCN to properly monitor the electrical facilities on ground and appropriately.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

Generally, organizations exist to attain a specific goal or goals with some available resources at its disposal. The efficient and effective utilization of its resources to produce goods and services goes a long way to demonstrate the management's ability to accomplish organizational goals (Jones, 2003).

However, the inability of an organization to judiciously manage its resources effectively means it has failed as an entity and cannot meet the challenge of providing goods and services to its consumers. As the world economy becomes increasingly dependent on technology that requires highly reliable electric power, reliable and qualitative electricity has been observed as a *sine qua non* element for modern living (Ali, Achinanya and Nuhu, 2004). On a global scale, reliable electric power availability has been observed as effective and indispensable machinery for the rapid industrial and economic growth of any nation (Megbowon and Oyebisi, 2005). Therefore by its importance in the society and its necessity for national economic growth, electrical energy supply is expected to be available 24 hour a day. Based on this importance, it is expected that electric power utilities throughout the world at large and Nigeria in particular must ensure they meet customer demands at a reasonable level of service reliability. As the absence of electricity for long periods causes discomfort and hampers productivity and also based on known fact that electricity consumption has become a parameter by which the standard of living as well as the level of industrialization of nations is measured (Muhammed, 2005).

2.2 PHCN IN PERSPECTIVE

The first electric power plant built in Nigeria was located in Lagos. It was built in 1898 and was managed by Public Works Department (PWD). NEPA, otherwise known as Power

Holding Company of Nigeria (PHCN) in its present form came into being in 1972, with a mandate to develop and maintain an efficient, co — ordinated and reliable power supply in the country. In 1973, only eight (8) of the present 36 States in Nigeria were directly connected to the National Grid. Today all states but one are fed from the National (Hamzat, 2005). PHCN'S system consist of ten (10) power stations (7 Thermal and 3 Hydro), with a total installed capacity of about 6000 Megawatts (6000MW).

Also, based on the report by Olivia Philip Consults (2013), by 2005, the transmission network in Nigeria consisted of 5000km of 330 kV lines, and 6000km of 132 kV lines. The 330 kV lines fed 23 substations of 330/132 kV rating with a combined capacity of 6,000 MVA or 4,600 MVA at a utilization factor of 80%. In turn, the 132 kV lines fed 91 substations of 132/33 kV rating with a combined capacity of 7,800 MVA or 5,800 MVA at a utilization factor of 75%. The distribution grid consisted of 23,753 km of 33 kV lines and 19,226 Km of 11 kV lines. In turn, these fed 679 substations of 33/11kV rating and 20,543 substations of 33/0.415 and 11/0.415 kV ratings. In addition, there were 1,790 distribution transformers and 680 injection transformers. Yet, the transmission network is overloaded with a wheeling capacity less than 4,000 MW, resulting to poor voltage profile in most parts of the network, especially in the North. This is worsened by inadequate dispatch and control infrastructure, radial and fragile grid network, frequent system collapse, comparatively high transmission losses (Olivia Philip Consults, 2013).

In comparison to other countries according to Maigida (2008) study, over the years there been very marginal improvement in electricity infrastructure. For instance, between 1985 and 2000, electricity generation capacity grew by a mere 10 per cent in Nigeria compared to 332 per cent in Vietnam, 142 per cent in Iran, 237 per cent in Indonesia, 243 per cent in Malaysia and 205 per cent in South Korea . Electricity generation capacity is also far below comparator

countries. Nigeria, with a population of over 150 million people, has an installed generation capacity of 6000MW compared to UAE 4740MW to a population of 4 million or South Africa that has 46000MW to 44million people. Hence, to ensure that qualitative power supply system is achieved and sustained, three functional zones or subsystems known respectively as generation, transmission and distribution must be sustained (Megbowon and Oyebisi 2005).

2.3 ELECTRICITY GENERATION, TRANSMISSION AND UTILIZATION

2.3.1 Electricity Generation

A good plant mix to provide for contingencies cannot be overemphasized for stability and security of power supply. Nigeria is blessed with abundant energy resources for the production of electricity. What is required is the investment to harness these resources to establish a strong and reliable power supply system. PHCN operates the following power stations Kainji,' Jebba and Shiroro' power stations use water for the generation of Electricity, Egbin and Sapele uses steam while Sapele, Afam and Delta power stations operates with gas. Ijora power station is run on diesel oil. Sapele has two stations, one runs on gas while the other uses steam for electricity generator. The total installed capacity of both the hydro and steam stations is 5876 megawatts (MW). The available generation capacity is 3088 MW, while the capacity of written off or scrapped units is 476 MW. The effective installed capacity is 5400 MW (5876 — 476 = 5400) made up of plants which are over 15 years on the average and require rehabilitation and repairs to sustain adequate and reliable generation capacity. Currently, 39% of annual energy is generated by hydro while 61 % is from thermal (PHCN, 2005).

2.3.2 Electricity Transmission

Electricity transmission is simply a process through which the generated energy is distributed to the consumers through the various sub-stations. Omoigui and Komolafe (2000) revealed that, there are twenty — four (24) 330KV transformer/switching substations and ninety

— two (92) 132KV transformer switching substation in the country. These substations are located over the entire 923768 square kilometers (km2) area that makes up Nigeria to supply the power requirements of each load centre. In addition there are about thirty – nine (39) 330KV overhead transmission lines stretching a total of about 4, 970 kilometers to link the twenty — four (24) 330KV substations. There are one hundred and nine (109) 132KV overhead transmission lines starching a total of about 4841 kilometers to link the ninety two (92) 132KV substations in various parts of the country from which the voltage is further transformed to 33KV, 11 KV, 6.6KV 3.3KV for distribution at 240 volts and 415 volts (Omoigui and Komolafe, 2000;Harnzat, 2005).

Primary distribution networks emanate from these substations. The sub — transmission scheme in the country is mostly radial, providing a single power flow route to consumers. Thus while commenting on the impact of transmission mode on electricity supply Omoigui and Komolafe posited that: "owing to the predominantly radial configuration of transmission lines, any slight changes in the operating point of any of the major plants can initiate disturbances which may lead to system collapse" (Omoigui and Komolafe: 2000:23).

Also Alamu and Ejiobih (2002) noted that the concentration of industries in the country is predominately one-sided thus resulting in overstressing of the lines and equipments of PHCN on one hand while the other end experiences less stress. This results in dynamically unstable equilibrium power system network.

2.3.3 Electricity Utilization

The distribution network has experienced very rapid growth especially with progressive rural electrification policy of the Federal Government. Most urban centres are developing very fast and power demand is on the increase. In terms of efficient and adequate supply however, numerous problems hinder the performance of PHCN. Ponnle, Popoola and Ale (2011) opined

that the power supply in Nigeria is generally unreliable as well as seasonally dependent with better power availability in wet season than dry season. Also, Caven (1998), noted that residential areas in some cities have suddenly been transformed into commercial centres thereby overloading the existing power supply facilities. The high cost of distribution materials has limited the ability of the Authority to cope as most urban planning and developments are carried out with prior information to the Authority to plan and provide the requisite electricity supply information.

Also according to Olivia Philip Consult (2013) report, access to electricity services in Nigeria is low, with about 60 percent of the population – Over 80 million people not served with electricity. Per capita consumption of electricity is approximately 100kWh against 4500kWh, 1934 kWh and 1379kWh in South Africa, Brazil and China, respectively. Under a business-as-usual scenario, the proportion of Nigerians without access to electricity services will continue to increase over time.

The Rural Electrification Program began in 1981 focuses exclusively on grid extension; costs per connection remain high and annual rate of connection is low. With the chronic shortage of available generating capacity and low tariffs for rural areas, there is little incentive for PHCN to champion an expansion programme. In all, rural electricity capital assets continue to deteriorate through neglect, vandalism and theft (Olivia Philip Consults, 2013).

In terms of efficiency and performance, the Nigerian electric power sector has been rated by the UNDP/World Bank Report 1993 as having one of the highest rate of losses (33%), the lowest generating capacity factor (20%), the lowest revenue at 1.56c/kWh, the lowest rate of return (-8%) and the longest average account receivable period (15 months), among a group of 20 low income and upper income countries. Electricity tariffs are below the cost of service and there is poor revenue collection. According to Tallapragada and Adebusuyi, (2008), about 30-40

percent of power supplied is never billed. The power sector incurs a cash loss of around US$2billion per month. Over US$400 million annually is spent by the Federal Government of Nigeria as an annual subsidy to cover losses and investment.

According to Adenikinju (2008) report on the comparison of selected power sector indicators of technical and financial efficiencies between Nigerian and the average for a group of African countries, Nigeria efficiency performance on all counts is much worse than for a set of middle income African countries. With installed generation capacity in Nigeria between 2004/5 amounting to a mere 42MW per million people compared to 404MW for middle income African countries. The per capita generated power in total electricity generated in Nigeria was 52 per cent compared to less than 1 per cent for Middle income African countries. The number of unplanned outages in Nigeria was also 30 times more than what obtained in the former group of countries. Labour efficiency is also poorer in Nigeria. Labour costs account for 48 per cent of operational costs compared to 29 and 11 per cent for low middle and middle income African countries respectively.

2.4 FACTORS AFFECTING POWER GENERATION, TRANSMISSION AND UTILIZATION IN NIGERIA

One of the key indices in gauging the development of any nation is its electricity consumption per capita; every facet of our social, economic and industrial development is linked to the availability and utilization of reliable electric power (Amadi, 2012). Absence of electricity for long periods causes discomfort and hampers productivity. It is also a known fact that electricity consumption has become a parameter by which the standard of living as well as the level of industrialization of nations is measured (Muhammed, 2005). Unfortunately, the majority of Nigerians have no access to electricity and the supply to those provided is not regular (Okoro and Madueme, 2004).

The Oxford Business Group (2013) has it that about 11% of the power generated in Nigeria is lost to transmission infrastructure deficits and limited grid. The report put the quantum of power being lost at 1,761 MW. It identified weak power transmission and inadequate gas supply as two critical issues that required urgent attention. To Caven (1998) delayed rehabilitation of plants and power supply equipment, lack of spare parts, and obsolete equipment are the major factors militating against efficient power supply in Nigeria.

Moreso, the challenges of low funding as well as the inability of revenue to cover costs of the power sector remains the a contending issues in the efficiency of power generation, distribution and utilization in Nigeria (Nnodim, 2013). Cost as a percentage of tariff declined from 83.3 per cent in 2001 to 42.6 per cent in 2003 before rising to 66.5 per cent in 2004. In addition to other demands on its revenues, the government has shown itself unable to continue to shoulder past energy financing responsibilities. Adenikinju (2008) also noted that the problem of inadequate gas supply has also been an important challenge faced by the power sector. Gas currently accounts for 75 per cent and 67 per cent of installed and available electricity capacities in the country respectively. Meanwhile, Dare-Alao (2013) sees government focus on power generation to the detriment of transmission and infrastructural maintenance as the major set-back to the effective performance of the nation's power sector.

Alamu and Ejiobih (2002) submitted that unequal distribution/transmission of load, bad conditions of the equipment due to improper monitoring and maintenance as well as frequent power surge due to natural incidences are the common problems facing the Power Utility Sector.

Iwayemi (2008) outlined the factors of poor electricity service in Nigeria as an outcome of:

1. Ageing and poorly maintained generating, transmission and distribution infrastructure facilities failures.

2. Weak financial and economic health of the state-owned company NEPA/PHCN. This derived from the prevalence of a regime of price control that had little concern for cost recovery. There were inadequate economic incentives for the company to engage in efficient production and investment behaviour due largely to the price subsidies and cross subsidies. The multiplicity of economic and non-economic objectives associated with state ownership imposed a social welfare-oriented pricing policy that did not generate sufficient profit margin. Notably, the largest debtors to NEPA were the federal, state and local governments.
3. Weak institutional framework and governance failures. The institutional and governance failures induced gross inefficiency in production, distorted investment choices and demand patterns, high costs of operation, low return on investment and expensive delays and cost overruns that encouraged widespread corruption.

Ayodele, (1998) highlighted some illegitimate activities which affects power sectors as;

- illegal electricity connections either to the national grid or the existing
- residential/industrial electricity outfit;
- illegal sales of electricity metres to prospective consumers;
- over/under billing and payment via unscrupulous business collusion;
- vandalisation of equipment, resold in most cases to public/private electricity institutions etc.

Furthermore, the Federal Republic of Nigeria (1975); World Bank (1991); Ayodele (1992, 1999) reported that the current status of electricity supply in Nigeria reflects that of an electricity supply crisis in which industrial growth and socio-economic development paces are kept below what is attainable by the economy. That is, the existence of an abnormal electricity

supply situation in which supply cannot catch up with electricity demand, thereby, creating an electricity supply-cum-demand imbalance in the Nigerian electricity market.

2.5 GIS AND ELECTRICITY FACILITY MANAGEMENT

Electrical distribution system has a spatial dimension to it, which calls for the need of GIS. The Geographical Information System can handle both spatial as well as non-spatial data, which makes it more beneficial over the traditional database. Moreover GIS has the functionality of having information as layers, which helps in a systematic and refined manner of managing voluminous data. The spatially referenced data provides useful reference for setting up of new facilities, necessary information on land use pattern for planning optimum expansion of network and other network operations and maintenance. The database can also handle non-spatial queries as done with any other normal DBMS.

The use of GIS in power system can greatly enhance the efficiency in energy sector. Proximity to the furthest customer and high cost to invest capital, are the reasons that make the distribution system as an important part of electrical utility, which endeavor to improve the reliability of general power system. Analyses such as selection of suitable areas, optimum path finding, the profile analyses, the engineering design of wires and towers, and the cost estimation can all be done using GIS (Dare-Alao, 2013).

Emengini (2004) noted that knowledge about physical assets of the enterprise is necessary to make strategic and operation decisions. Thus, to take wise decisions vital to the operations, growth and management of electricity distribution facilities, information must be collected and analyzed to its full extent, such information contributes not only to efficient services, but also to the operation and maintenance of assets, and to the sensible planning of extensions and new works. This information helps in spatial decision making and it makes the

information easily updateable and can cater for the needs of maintaining large power infrastructure.

Electric utilities are realizing the benefits of GIS technology in the management of facilities for engineering, construction operations, and maintenance and services purposes. Problems of planning in distribution system can be solved by using new methods and specific techniques. Complexity of electrical distribution system and necessity of accurate up-to-date information of the network assets is a reasonable intention for introducing new method of information technology (Dare-Alao, 2013).

More importantly, the power industry is expected to keep track of the electrical facilities (poles, circuits, power lines and transformers) involved in the distribution of energy to the end-users. With the aid of GIS, variety of information can be better organized on a computer system linking the database to an output map (Ezeigbo, 1998). GIS can effectively be used to manage and monitor information on the distribution of electricity to end-users including information describing their spatial and non-spatial attributes such as geographical location and electricity use (Slipes, 2007).

High customer demands force different kinds of technologies and skills to be banked upon by utility companies in order to enhance the level of production. For this reason GIS has become in effect, one of the tools for generating, arranging and managing geospatial information. Sipes (2007) shows a transition in recent years from the ways in which utility companies which have previously been engaging GIS as departmental solution to an enterprise solution where data is accessible by thousands of people.

Korte (2001) demonstrated that GIS can be employed to some extend in network tracking to determine a particular path or route through a network. This however supports the fact that GIS could be employed in agencies that regulate networked services. This can therefore be used

as an important tool in distribution power industries to determine the power distribution capacity of the system along the way or perhaps to determine the most favourable path alone a straight network.

Above all the greatest supremacy of GIS is visualisation. The entire electrical network can be visualised as it is laid on the ground. Just by looking at the map and clicking at a particular feature (say a transformer), all the information (both location and engineering information) is displayed. This provides a more flexible understanding of the network and hence a faster approach to the solution (Suleiman and Ali 2009). Also, Ayeni, Kufoniyi and Akinyede (2003) noted that Geospatial Information (GI) is very essential to economic planning and national development. This is buttressed further by Alamu and Ejiobih (2002), when they concluded that a well maintained utility information infrastructure gives up-to-date information on what is where, the state of it, the reaction other actions on it would cause, how it can be harnessed for optimum use of the people and economy.

Schneider *et al* (2005) opined that sources of transformer failure can be in two modes; reversible (defects) and irreversible mode (fault). The distinction between the two processes is not clearly defined, but the presence of defect or fault in transformers can be detected through system monitoring and diagnosis.

Most of the defects that may cause system failures in electric power network are of reversible mode and could have been corrected in the field if appropriate monitoring system capable of detecting such defects is put in place. Approximately 80% of transformer failures occur within the age range of 10 to 38 years due to wear-out problem. These failures could be predicted and prevented through early detection of problems, at the incipient stage, which will help to reduce the risk and costs of unexpected failure, drives conditions-based maintenance,

reduce cost of maintenance and repair, and extend life of transformers (Wasserberg, Borsi, Zhang and Gockenbach, 2007).

According to report by Stirl, Skrzypek, Tenbohlen and Vilaithong (2006) in Germany a critical damage of a 350 MVA grid coupling transformer 262 was avoided by detection of a partial flashover of layers of a bushing indicated by a change in the bushing capacitance. Collateral damage was avoided by detection of an oil leak on a 850 MVA generator transformer by means of monitoring the bushing oil pressure. Operating condition of a 75 MVA furnace transformer was made transparent by monitoring the condition of the transformer from beginning of a fault until collateral damage. The monitoring system provided advance information before system failure. Another report on the intensive monitoring of two 275/132kV 180MVA transformers at a substation in the UK using multi agent system technology shows an enhanced estimation of the transformers health. This system integrates various diagnostic and anomaly detection modules, with data from approximately 50 sensors captured every five minutes. The integrated system combined with knowledge-based method can be used to interpret the obtained data from the site (Catterson, Rudd, McArthur and Moss 2009).

Abdelmalik (2013) emphasised that experience from on-line management system shows that defects building up in power transformers while in operation can be detected earlier with the deployment of an efficient on-line monitoring system, which reduces the potential of transformer endangerment in the field, achievable by developing a real-time condition monitoring system that will be based on integrated technique. Integration of different measuring methods can serve as sophisticated tools to take decisions on the operation of the transformers.

2.6 CAPACITIES AND UTILIZATION OF TRANSFORMERS

According to an online electrical engineering study site (Electrical4u), “transformer” is seen as a static machine used for transforming power from one circuit to another

without changing frequency. The importance of transformer in electricity power generation cannot be overemphasized, more especially in a country like Nigeria where power transmission has been characterized by current fluctuations. For instance, power generation in low voltage level is very much cost effective. Hence electrical power is generated in low voltage level. Theoretically, this low voltage level power can be transmitted to the receiving end. But if the voltage level of a power is increased, the electric current of the power is reduced which causes reduction in ohmic or I^2R losses in the system, reduction in cross sectional area of the conductor i.e. reduction in capital cost of the system and it also improves the voltage regulation of the system. Because of these, low level power must be stepped up for efficient electrical power transmission (http://www.electrical4u.com/electrical-power-transmission-system-and-network/). This is done by step up transformer at the sending side of the power system network. As this high voltage power may not be distributed to the consumers directly, this must be stepped down to the desired level at the receiving end with the help of step down transformer. Based on the distribution level (transmission power of up to 10MVA) there are two main categories of distribution transformers.

2.6.1 Liquid Filled Transformer

This type of transformer uses mineral oil or replacement fluids such as synthetic or natural esters. Liquid filled power transformers are very important components of electrical transmission and distribution network. Their bushings, tap changer, and insulation system are critical to the operation of the power equipment. Their reliability and uninterrupted operation is a key factor in profitable generation, transmission and distribution of electricity. The body heat is transported through the tank walls by thermal conduction and removed by the natural or forced convection of air. They are usually the most compact and cost efficient solution. Liquid-filled transformers are usually used when the transmitted power exceeds around 10 MVA, special

designs are required to cope with the mechanical forces of short circuit currents, higher insulation levels and increased cooling requirements. The insulation between the windings becomes more and more demanding at higher voltages. Furthermore, resonance effects inside the winding itself have to be considered to avoid insulation failures during highly dynamic impulse stresses such as lightning strikes which may reach amplitudes of one to two thousands kilovolt with a 1 μs rise time (http://www.abb.com/product/us/9aac30300162.aspx).



2.6.2 Dry Type Transformers

These types of transformers are preferred in environments where fire safety is of special importance such as, for example, underground substations, mining sites, marine and some industrial applications. Dry transformers in closed environments usually have a forced internal convection flow of air to ensure sufficient cooling of the transformer core. (http://www.abb.com/product/us/9aac30300162.aspx).



2.6.3 Traction and special transformers

Railway vehicles use a special type of transformer that must be highly compact, reliable and robust. Operating frequencies vary (according to countries and systems) from 16.7 Hz to 60 Hz with power classes of up to 10 MVA. To permit trains to cross borders between countries, traction transformers must be compatible with the different frequencies and power systems. Also, private residence, banks, medium/large scale companies as well as large cooperate organizations uses this type of special transformers.

Another type of transformer based on capacity is called Generator Step-up Unit (GSU). This type of transformer is usually located directly next to a power plant. It transforms the electric power from the medium voltage of the generators to the high voltage transmission level. To balance power flow between parallel power lines, phase shifters can be used. These are transformers (usually with a 1:1 translation ratio) that adapt and control the phase angles of voltage and current to optimize the power transmission capacity of the lines. Phase shifters exist up to a power rating of 1,500 MVA.

According to Claessens (2013), transformers with power ratings above some ten MVA are a key element in the supply of large regions or industrial areas. As a rule of thumb, it can be considered that one person has an average electrical power demand of 1kVA, which means, that a 400 MVA transformer transfers the power needed by 400,000, the equivalent of a medium sized city. Such transformers have to comply with special requirements on safety and reliability and also have to provide a very high efficiency and low sound level. In recent decades, high voltage DC lines have also become increasingly important, especially in large countries such as China where they connect industrial centres to the remote regions where the electricity is generated. More so, Suleiman and Ali (2009) noted that PHCN distribution transformers that are commonly found in Nigerian network are 50KVA, 100KVA, 200KVA, 300KVA and 500KVA.

2.7 CHALLENGES OF TRANSFORMER DISTRIBUTION AND UTILIZATION

In Nigeria, most of the power sub-stations are over 40 years old and power transformers in the sub-stations have useful life of about 40 years and this put the transformers on serious ageing problem (Okoro and Chikuni, 2007). Lack of expansion and Improper planning of electric power distribution network often put the distribution transformers on overload. They therefore require adequate care to extend their useful life time, while maintaining system reliability.

Abdelmalik (2014) emphasized that since the electric power transformer is a vital component of electrical transmission and distribution network, reliability of the insulation system in a transformer is a key element for a reliable operation of the transformer. Failure of the insulation system will affect the operation of the entire network. Some failures may result from manufacturers' fault, but failures that occur due to accelerated ageing of the equipment can be limited or avoided by preventive maintenance. Asset management therefore plays an important

role in the effective transmission and distribution of the generated power to the end user. Acquisitions of necessary information will enable asset managers ascertain the accurate condition of power equipment, including aged and new power transformers.

Suleiman and Ali (2009) attributed overloads and poor maintenance of transformers as factors responsible for a total breakdown of over 31 transformers with an estimated cost for repairs and replacements amounting up to 30 million naira in a related study carried out in Sokoto state, Nigeria. It was also reported in the same study that transformers servicing town and GRA areas were under semi-reliable conditions because they are subjected to load beyond their identified plate capacity, with approximated mean time between failures (MTBF) of transformer if not serviced under Town and GRA areas accounting to about 9 months and 14 months respectively. Also Caven (1998) opined that residential areas in some cities have suddenly been transformed into commercial centres thereby overloading the existing power supply facilities. The high cost of distribution materials has limited the ability of the Authority to cope as most urban planning and developments are carried out with prior information to the Authority to plan and provide the requisite electricity supply information.

Degeneff (2004) noted that energy loss takes place in transformers while in operation. The load losses take place at the windings. The primary and secondary windings in most transformers are either copper, aluminium, or one of them may be aluminium and the other copper. Application of load current on the windings leads to interactions between the moving current carrying particles and the atomic ions that make up the conductor. This interaction leads to ohmic heating, which results to abnormal state such as; general overheating leading to abnormal rise of the oil temperature due to cooling deficiency, poor distribution of oil flow and core overheating.

Other factors that can lead to fault are local heating in places of poor joints, breakdown of oil due to severe contamination, formation of film coating leading to reduction in contact surface, local heating due to excessive eddy current etc. These will result in overheating, sparking and arcing, insulation deterioration, generation of gases from the transformer (CIGRE working group, 2002).

Ingress of water from the atmosphere can also increase the moisture content in transformer insulation. This is mostly due to flow of wet air or free water due to poor sealing under action of a pressure gradient. The presence of bubbles in oil may cause critical discharge which results to interruptions in power transmission network (CIGRE working group, 2002). The withstand strength of transformer will naturally decrease over time as a result of normal ageing, but defects such as excessive moisture in cellulose, oil contamination due to ageing, insulation surface contamination resulting from adsorption of conducting ageing products such as copper sulphide, partial discharge, creeping discharge which may lead to failure at normal operating condition of transformers, accelerated insulation ageing resulting from overheating, accelerated deterioration of components such as bushings and on-load tap changers (OLTCs), etc. could lead to accelerated degradation of the system (CIGRE working group, 2002).

Shomolu (1996) highlighted various factors that affect the life expectancy of various equipment used in power systems. Some of these factors are: -

- The physical environment,
- The load to which it is subjected,
- The quality and competence of maintenance personnel,
- The availability of spare parts,
- The manufacturing standard and its specific rating; and ingenuity and resourcefulness of the maintenance personnel.

Shomolu (1994) outlined the life expectancy period of some power supply equipment.

/N	Equipment	Life Expectancy
	Power transformer	50
	Grounding transformer	25
	Distribution transformer	25
	Circuit breakers	25
	Transformer line tower	50
	Current transformer (CTS)	30
	Potential transformer	30
	Capacitor banks	10
	Protective relays	20
0	System control and Data Acquisition (SCADA)	10

Ponnle*et al,* (2011) submitted that inadequate and erratic gas supply to the thermal stations is a second major constraint that hampers electricity generation with a resultant effect of massive load shedding on the electricity users. For instance Caven (1988) noted that the thermal power stations located in Afam, Delta and Sapele are most severally affected by erratic gas supply, despite their proximity to the natural reservoir of gas in Nigeria, At Delta power station the generation capacity fluctuates from 150MW to 350MW because of the gas supply limitation, whereas the plant availability exceeds 450MW on the average. However, availability of the hydra plants has been good but the constraints in hydra power generation mainly concerns the water in the reservoirs which is seasonal and dependents on natural rainfall, in the event of shortage in rainfall results in the depletion of the hydro reservoirs and consequently power supply (Caven, 1998).

A lot of expansion of the supply has been carried out but this has not been matched by corresponding expansion of transmission and distribution network: The result of this has been the occurrence of multiple overloaded subsystems. Furthermore the 330KV and 132KV

transmission lines in the National grid are mostly radial and very long and consequently, results in situation where voltage Control and security of the power supply become problematic during faults or system disturbances (Caven, 1998).

Ijewere (2006) reported that lack of effective communication systems, vandalism or unpatriotic acts of saboteurs, weather which manifests in the form of harmattan dust that clog or block the air intake filters of gas turbines, inadequacy of staff welfare and development scheme put in place by the authority adversely affect power supply. Additionally, more than 80% of the power transformers in the grid substations are overloaded. This results in frequent power outages, low current output and consistent resorting to load shedding (Caven, 1998)

Kaduna electricity situation mirrors Nigeria's power dilemma. Business Day Research and Intelligence Unit (BRIU) concluded a survey to evaluate the Power sector in Nigeria and its impact on Nigerians. The sample size was taken from Kaduna state, the educational nerve centre of Nigeria, home of several educational institutions, firms, financial institutions, companies and other businesses. Unsurprisingly, when asked the people their views on the current state of power supply based on personal experience, the respondents are very dissatisfied. Analysis among the respondents revealed that only 1.3 percent are very satisfied with the level of electricity provided; 7.5 percent are somewhat satisfied; 3.8 are neither satisfied nor dissatisfied while the balance of 78.8 percent are very dissatisfied. Furthermore, the respondents also had similar views and experience not just with the power generation segment but also the distribution sub-sector, as 70% of residential customers are very dissatisfied with the services of their distribution companies, otherwise referred to as DISCOs. In addition, 12.5 percent are somewhat dissatisfied while 8.8 percent are neither satisfied nor dissatisfied and the balance of 8.8 percent is somewhat satisfied (Omosomi,2015)

The Samaru, PZ and Dogarawa Distribution Companies are responsible for the receipt of electricity from the generating companies also known as GENCOs. Overall, the DISCO segment of the electricity industry have decried the dilapidated distribution of infrastructure across the state as a limiting factor in meeting expected capacity to supply power to consumers. However, we expect that there should have been some noticeable investment in the distribution infrastructure in the sector now that it has been transferred to private owners and also with this new administration. Consequently, in spite of some level of progress in infrastructure rehabilitation and overhaul in the distribution sector, less than 50 percent (43.8 percent) have received and make use of the pre-paid metering system, which is the new and transparent method for billing electricity usage ensuring that consumer pay for only what they consume. As a result, 56.3 percent still make use of the old (post-paid) metering system despite the privatization reforms in the sector. The estimated billing system lacks transparency as consumers are often charged for consumption that often does not reflect requisite usage. When asked to opine on the rate of power supply in the last four years, 33.3 percent believed that it had not improved while 27.7 percent stated that it had deteriorated. 16 percent responded that power supply remained unchanged while 14.8 percent declared that it had slightly improved and the balance of 8.6 percent believed that electricity services had significantly improved (Omosomi,2015)

CHAPTER THREE: THE STUDY AREA AND RESEARCH METHODOLOGY

3.1 THE STUDY AREA

3.1.1 Location

Sabon Gari LGA is one of the important LGA in Kaduna State; it is located on a plateau at a height of about 2,200 feet above sea level on the contour of Kaduna state, northern Nigeria and more than 400 miles away from the sea. The LGA lies between Latitudes 11°15' N to 11° 3'N of the equator and Longitudes 7° 30' Eto 7° 45'E of the Greenwich meridian with a total land area of approximately 600Km Z (Google earth, 2011). It occupied a land area of about 263km ^{2}.It has boundaries with the neighboring LGAs on the east by Soba, to the north by Kudan, Giwa to the west and Zaria to the south. The Local Government Secretariat is presently situated at Dogarawa village and the local government has eleven wards namely AnguwanGabas, Chikaji, Muchiya, Dogarawa, Basawa, Jushi, Sakadadi, Shika, Hanwa, Jama'a, BomoabdZabi. It has six districts which include Sabon Gari, Hanwa, Muchiya, Basawa, Samaru and Bomo (See Figure 3.1 on page 33).

Designed and laid out by British colonial administrators with suburban "garden city" standards in minds occupied and built by commercial southern Nigerians, more recently by northern Nigerian escaping from traditional restrictions with crowded village or city life as an ideal, and built in the pre-auto, pre-electric age, Sabon Gari, is a combination of early twentieth century colonial and Nigerian ways. It existence is geared to the railway, commerce and provincial administration with railway to Kano, and formally to Jos. The railway corporation has made Sabon Gari LGA a focal point for collecting overshadowed by Kaduna. Recently the local market itself has become more important with an increase in the number and size of educational institutions and factories.

The Government Residential Area (GRA) forms the largest part of the old European location, is composed of large plots (1-2 acres) with spacious houses and public offices surrounded by extensively planting of ornamental trees and shrubs. The curved streets, trees lined and shady, are broad and well maintained. The Zaria club with its polo ground race course and golf course separates the GRA from the residential compounds of the senior railway officials, creating an open park in the midst of an ideal type of English suburban life in which house gardens, trees open space and quiet set the tone.

The Commercial areas south of the GRA popularly known as Hanwa fly over and has spacious environment. The roads are crossed at right angle and bound large plots on which both trade and residence can go on with little conflict. Sabon Gari is the gateway to important towns of Kano, Funtua, Gusau, Katsina and Sokoto. It is home to some of the best educational institutions in Nigeria.

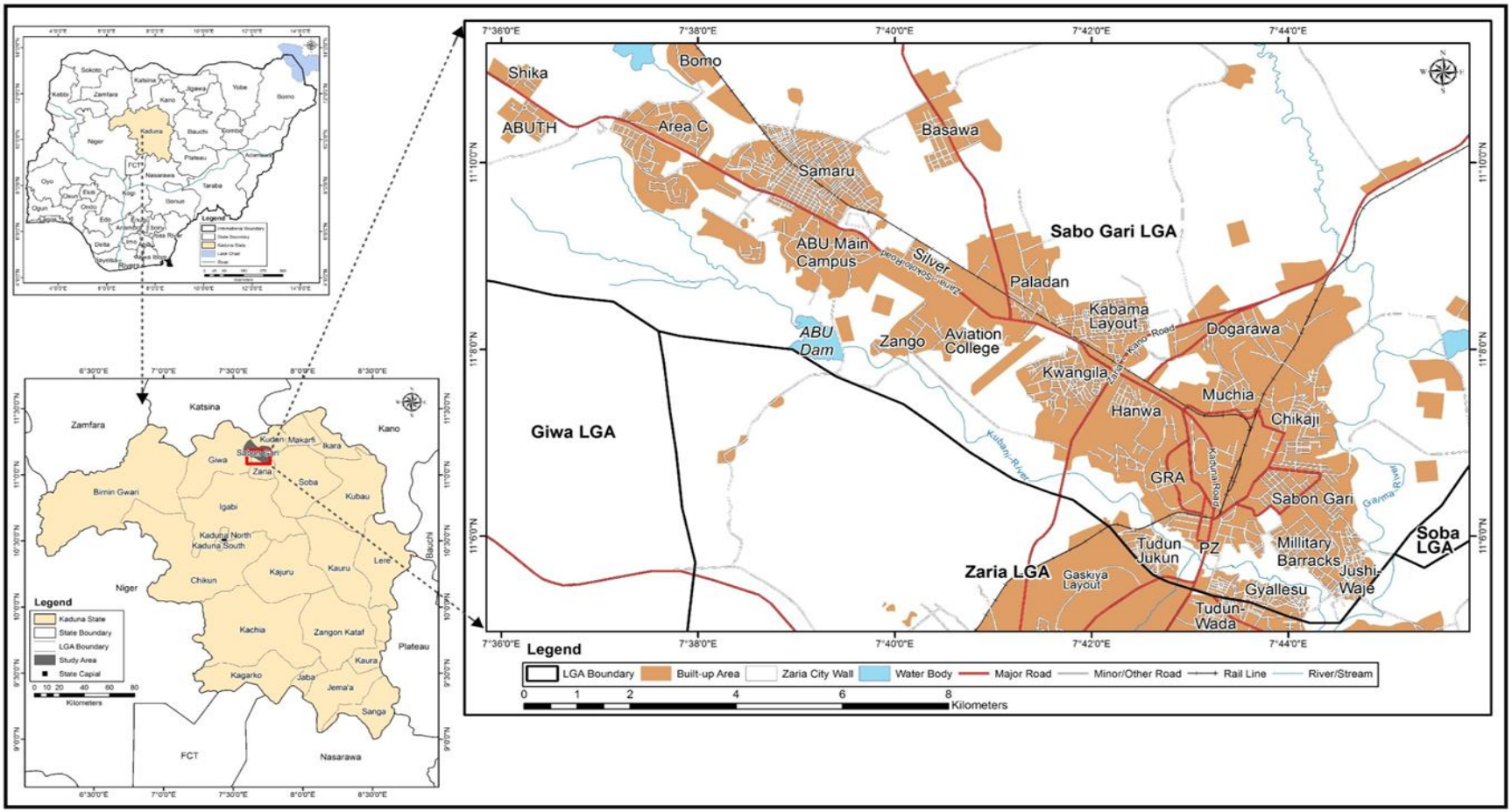


Figure 1: Map of Sabon Gari LGA
Source: Adapted and modified from the administrative map of Kaduna state/Google Maps, 2014

3.1.2 Physical Setting

3.1.2.1 *Climate*

Sabon Gari possesses a tropical continental climate which also falls under the AW of Koppens Climatic classification with a mean daily maximum temperature which gets to its peak in April and a minor one in October. The mean minimum temperature of 11 °C occurs in December and January to a high temperature of about 40°C in July and August. Sabon Gari enjoys a tropical savannah climatic type dry season practically varies and wet season with high sun. The mean annual rainfall is about 1200-1500mm, these seasonal characteristics affects vegetal cover.

The dry season (winter-harmattan period) covers from November to February; fluctuations in daily November temperature are from 16°C to 32°C, in which the frequency of dust increases. As the season moves on, the relative humidity falls from 36% in November to 35% in January (Ojo, 1982).

The harmattan winds become intense during December-January period and thus lower further the temperature to 14°C in January. And because of the variation of temperature between morning and night and afternoon, it fluctuates between 14°C and 31 °C with a variation of 17°C. During the hot season (March-April) humidity jumps from 20% in February to 31% in April is considered to be the hottest (36°C). Clouds appear to reduce the temperature by as much as 6°C.

The period between may-June is known as thunder storm season. Humidity at this period rises from 69% in May, 77% in June with maximum temperature of 33°C in May and 31 °C in June. The wet season starts from July to October.

The overall weather and climate of Sabon Gari depend to a large extent on the interplay between the two air masses, the tropical continental air mass, which comes from north-east and

the tropical maritime air mass which comes from southwest over the Atlantic Ocean. These two air masses in their boundaries form the inter-tropical discontinuity (ITD or ITCZ).

The region experiences convectional rainfall type with single maximum and a long-term average of about 1100mm per annum. Of great importance is the seasonal character of the rainfall. About 90% of the rains fall between April and October with the heaviest recorded in July and August. Monthly total can vary as well as the annual, with the mean annual rainfall of 800mm (Ojo, 1982).

Onset of the rainy season is highly variable and unpredictable; although long-term average appears to be first week of May (Owonubi and Olorunju, 1985). Variability in the cessation date of the rainy season has also been observed. Akintola (1986), for example, reported that the expected mean cessation date of the rainy season is October 8th with an upper limit of October 23rd.The North East Trade wind (Tropical Continental Air mass) characterized by hazy to dusty conditions lowers temperatures to as low as 10^0C at night. In the afternoons, up to 42^0C is sometimes recorded.

3.1.2.2 *Soils and Vegetation*

The soil of the area is predominantly of the leached ferruginous tropical type which is derived from both the basement complex and the sedimentary rock. A few occupying digressional areas and valley bottoms are hydromorphic soils.

The soils are characterized by a pH of about 7.70, the total porosity of 35% and a low cation exchange capacity. The soils contain 41% sand, 44% silt and 15% clay proportions. There are variations from place to place of these parameters, due to irregularity of rainfall and absence of vegetal cover, high intensity of rain generates surface runoff that results in stripping and gulling (Bello, 1973).

The climatic climax vegetation is of guinea savannah. It is characterized by moist wood and with relatively dispersed trees surrounded by thick bushes of grasses and shrubs (Jaiyeoba, 1986). The seasonal features of the rainfall in this area reflects on the vegetation which assumes various shades of green in the wet season but quickly turn brown pale and yellow in the dry season. The vegetation is described as that of the Northern guinea savanna type, which is a woodland vegetation type characterized by presence of *Isobelina doka* and other genera of the specie and grasses. Presently, it can best be described as the derived savanna due to human influence and interference over a long period of time. It is characterized by sparse shrubs or trees, grasses of tuft cover and clusters of trees along water courses.

However, human activities have greatly influenced the natural vegetation of this area. This led to evolution of concept known as the exotic or man-made vegetation. Some of the trees are non-native of the original vegetation.

3.1.3 Historical Development

The name Sabon Gari Local Government Area (LGA) of Kaduna State, a unique home of business men and women, centre of academic excellence and one of the food baskets of the state, it has its headquarters at Dogarawa, (a growing village located at the centre of the LGA). Sabon Gari LGA came into being through several trans or malign of Sabon Gari town with Native Authority Administrative system, (now the local Government system).

Sabon Gari town from which the local Government derived its name was established as a result of the development of communication, commerce and military establishment in the area after it was formally created by the British in the colonial administration in the north as a rehabilitation centre for railway workers in 1903.

It became one of the five urban centres in the northern part of the country; the others are Kano, Jos, Kaduna and Zungeru. This development facilitated the migration of the people from

all the different parts of the country into Sabon Gari town to give it a unique cosmopolitan nature and outlook. Towns such as Dogon Bauchi, JushinWaje, Tsugugi, Unguwar Kanawa, Muchiya, Chikaji, Hanwa, Palladan Jama'a, Basawa, Samaru, Bomo, Sakadni, Gwanda, Zangon Darbarnnnarbarno, Zabi, Shika Dam, Katanga, Tobu, Hayin Dogo, Ungwar Jaba, Daurawa, Kwangila, Ungwarmai Gwado, G.R.A. and the Local Government Headquarters Dogarawa to form one Administrative block, which gave it a district status.

When the local Government councils were first created in Nigeria, Sabon Gari District which was itself being transformed from Native Authority System to a Local Government system subsequently, Sabon Gari District and Soba District were derived out of Ikara Local Government and merged to create Sabon Gari Local Government council. Created on the 27th of August 1991, by the then Military Administration under retired General and President Ibrahim Badamasi Babangida, carved out Sabon Gari District from Soba Local Government council to form the now existing Sabon Gari Local Government Area (LGA) (Abu.edu.ng (2014).

3.1.4 People and Population

The population of the old Sabon Gari district in 1932 was 3,109, but by 1939 it rose to 6,657. The inflow of people from all parts of Nigeria is what is responsible for the multi-ethnicity of the people present in urban Sabon Gari today. The old Sabon Gari District continued to grow after the Second World War, the population was 10,717. In 1962, the population increased to 15,842. Based on the 1991 census, the population was 48,858. In March 2006, the total population was 291,358, with female and male population of 142,247 and 149,111 respectively (NPC, 2009).

The inhabitants include Hausa, Fulani, Gbagi, Nupe, Yoruba, Ebira, Igbo, Kaje, Kagoro, Tiv, Idoma, Igala, Ikulu, Jaba, Ninzom, Kanuri, Zuru and a host of others. The density of the

population ranges from 50-300 persons per square kilometer and the heaviest population was found in Sabon Gari and Samaru.

Since the inception of Sabon Gari in 1908 it has kept on growing and has since given rise to satellite towns such as Tudun-Wada, Samaru, Palladan, Muchia and Chikaji (Abu.edu.ng, 2014).

3.1.5 Land Use and Socio-Economic Activities

Being an urban settlement, the people of Sabon Gari LGA are mostly civil servants and traders with a large population in the rural area involved in subsistence farming. The population growth has altered the setting as more lands are converted to residential uses. During the day time, wide streets and roads are chocked up by people and traffic. Street hawking is the order of the day. This also resulted from concentration of the urban informal activities around the Sabon Gari area particularly the Central Business District (PZ area).

The major activities around Sabon Gari include scattered cultivation and farming activities during rainy season and grazing activities. Market gardening or Fadama cultivation takes place at the valley bottom or near the stream channels. This type of cultivation last all through the dry season and into the early period of the raining season. Some of the agricultural produced cultivated in the area are; yam, cassava, cocoyam, Maize, cowpea, guinea corn and millet. Some of the major cash crops cultivated in Sabon Gari include; cotton, ginger, groundnut, and soya beans. It also supplies urban population with perishable like vegetables, fruits and many more.

There are also industrial and general commercial activities, with large scale manufacturing industries which manufacture cottons, mattress, chalk etc located within Sabon Gari industrial estate because Zaria forms part of the country's industrial zone belonging

to the Kaduna-Zaria-Kano industrial axis. This in turn promotes commercial activities and services.

Moreso, Sabon Gari grew and even extended to other satellite towns like Hanwa, Palladan, Samaru and others. This continual growth and extension of Sabon Gari was attributable to the establishment of the Zaria Educational institution like Ahmadu Bello University, Nigerian College of Aviation Technology and others. Therefore, the explosion of commercial activities and services is the consequence (Abu.edu.ng, 2014).

3.1.6 Social Infrastructures

There is a well-developed transportation network is Sabon Gari, especially with the construction of the Baro-Zaria railways in 1911, which made the area an important route centre that linked various parts of the country. Road network in the area is also well developed composed mainly A.B.C types. A good example is the road dualization from Kofan Doka to PZ among others.

Educationally, Sabon Gari is indisputably referred to as the "educational nerve centre" of the Northern Nigeria; with massive concentration of institutions of higher learning. Some which are the Ahmadu Bello University (A.B.U), College of Art, Science and Technology; Institute of Administration Tudun Wada and the Regional Research Station of the Ministry of Agriculture now Institute of Agricultural Reasearch (IAR) in Samaru, Nigeria College of Aviation Technology, National Institute of Transport Technology (NITT), National Research Institute of Chemical Technology (NARICT), Federal College of Education (FCE), Federal College of Chemical and Leather Research Technology (CHELTECH), Nuhu Bamalu Polytechnic among others. There are also about sixty nine (69) primary schools and thirty-one secondary schools (Abu.edu.ng, 2014).

Electricity supply in the study area, followed the national trend of less than 12 hours of daily supply in most parts of the LGA, with the remotest parts receiving less than 8 hours due to abandonment/decay of power transmission facilities, except for Ahmadu Bello University that enjoys an uninterrupted daily supply due to their connection to a special line (Blue Line in 2006). On the other hand, infrastructures like health care centers are evenly distributed with about (11) primary health care centers (PHC) that spread across the area. More so, pipe borne water supply is also enjoyed in most part of the area especially in and around the satellite areas. This is attributable to the presence of Kaduna State Water Board established in 1939 to provide portable water to Zaria and its environment (Abu.edu.ng, 2014).

3.2 METHODOLOGY

This section presents the reconnaissance survey, types of data, sampling technique and data analyses

3.2.1 Reconnaissance Survey

A reconnaissance survey was conducted to be well familiarized with the study area. This gave the researcher an in-depth knowledge of the electricity supply and utilization challenges in the study area. Also the survey helped to determine the sampling techniques to be employed in selecting the sampling areas as well as to determine the various issues to be address in the questionnaires.

3.2.2 Types of Data

The following were the types of data used for this study:

(1) Data on the location of transformers;

(2) Data on the number of transformers in Sabon Gari;

(3) Data on the type and ownership of transformer used;

(4)Data on the status of the transformer; and

(5) Data on the level of utilization of the transformer.

3.2.3 Primary Data/Sources

The primary source provided information on power supply and distribution to residential and commercial areas, time and duration gotten from questionnaires and interviews. The questions were designed for residents in the service area. The questions included the number of transformers found within the service area, the quality/frequency of power supply, place / type of resident etc.

3.2.4 Secondary Data/ Sources

This was obtained from PHCN records, books, journal publications, other sources are published and unpublished works from existing materials, on-line materials, and Conference papers among others to know how electricity transformers are been distributed and utilized within and outside the study area.

3.2.5 Sampling Technique

In order to select the respondents to be interviewed, a multi sampling technique was used. In the first stage, residential houses were used as sample points, this is because, each house is assumed to be connected to the PHCN power grid. Hence questionnaires were administered to every of the occupant present and also to KEDCO staff. To achieve this, the 2006 housing population census of Nigeria was used to determine the number of houses in the study area and the total number of houses in Sabon Gari is 52,977 (NPC 2006).

In the second stage, sampling technique was used to select the specific areas to be sampled in the study area. These selected areas are Sabon Gari, Samaru, PZ Area and Hanwa. The reason for the selection of these areas was due to the fact that they have most of the information required for the study; hence the research is limited to a proportion of the study area selected for study.

Thirdly, to determine the sample size, Kregcie and Morgan (1976) formula for sample size selection was used. According to the formula, population between 50,000-60,000 was use a sample size of 361. Hence, 361 respondents were sampled.

Also, 50 staff from the three (3) PHCN units in the study area was sampled. The sampled staff comprised of field engineers and heads of various units. The sampling of 50 staff was informed by the information gathered on the manpower capacities of the units during the reconnaissance survey.

Lastly, to determine the specific number of respondents to be sampled in the selected areas, reconnaissance survey was carried out in order to know the population and the number of houses in the study area. Based on this, questionnaires were distributed proportionally to the housing composition of each type of houses within the study area, while the specific respondents in each of the randomly selected houses were interviewed.

Table 3.1 Distribution of Housing Units and Proportion of Respondents to be Sample

S/N	Type of Housing Unit	Housing Units Populations	Proportion of Samples
1	Separate stand house	31,107	212
2	Hut structure made of traditional material	2773	19
3	Flat in block of flats	6119	42
4	Semi-detached house	4202	28
5	Room/let in house	8137	55
6	Informal/improvised dwelling	299	2
7	Others	488	3
Total		**52,977**	**361**

Source: Adopted from NPC 2006 Housing Population Census Report

3.2.6 Data Analyses

To achieve objective one, field counting of the transformer was carried out alongside PHCN records in order to get the exact number of transformers in the study area. In determining the absolute location of the transformers a GPS device was used. The coordinates of transformers obtained from the field were put in an Excel sheet and imported into ArcGIS where they were appropriately displayed as shape file point features.

To achieve objective two, the following fields were used to create the database. The fields include: Transformer Id, Easting, Nothing, Substation, Ownership, functioning and non-functioning, problematic and non-problematic. The tables were populated with the attribute data obtained from the field as well as from the PHCN office.

In this aspect to achieve this objective questionnaire were designed and administered to the respondents in order to get information on how the electricity transformers in the study areas are distributed and their levels of usage. i.e. if they are over utilized or underutilized. Also, the number of houses that make use of one transformer in each area and how good the transformers in the study area are. Responses from questionnaires were analyzed using simple percentages in SPSS software.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter is a presentation of results anddiscussionof data obtained from the field. The results are presented in Figure 4.1 to 4.8. Under the following heading; location of transformer, the database of transformers and the utilization level of the electricity transformers.

4.2 LOCATION OF TRANSFORMER

Figure 4.1 shows the location of all transformer obtained thorough GPS-Base fieldwork. Figure 4.2 shows the location of public and Figure 4.3 shows the location of dedicated transformers.

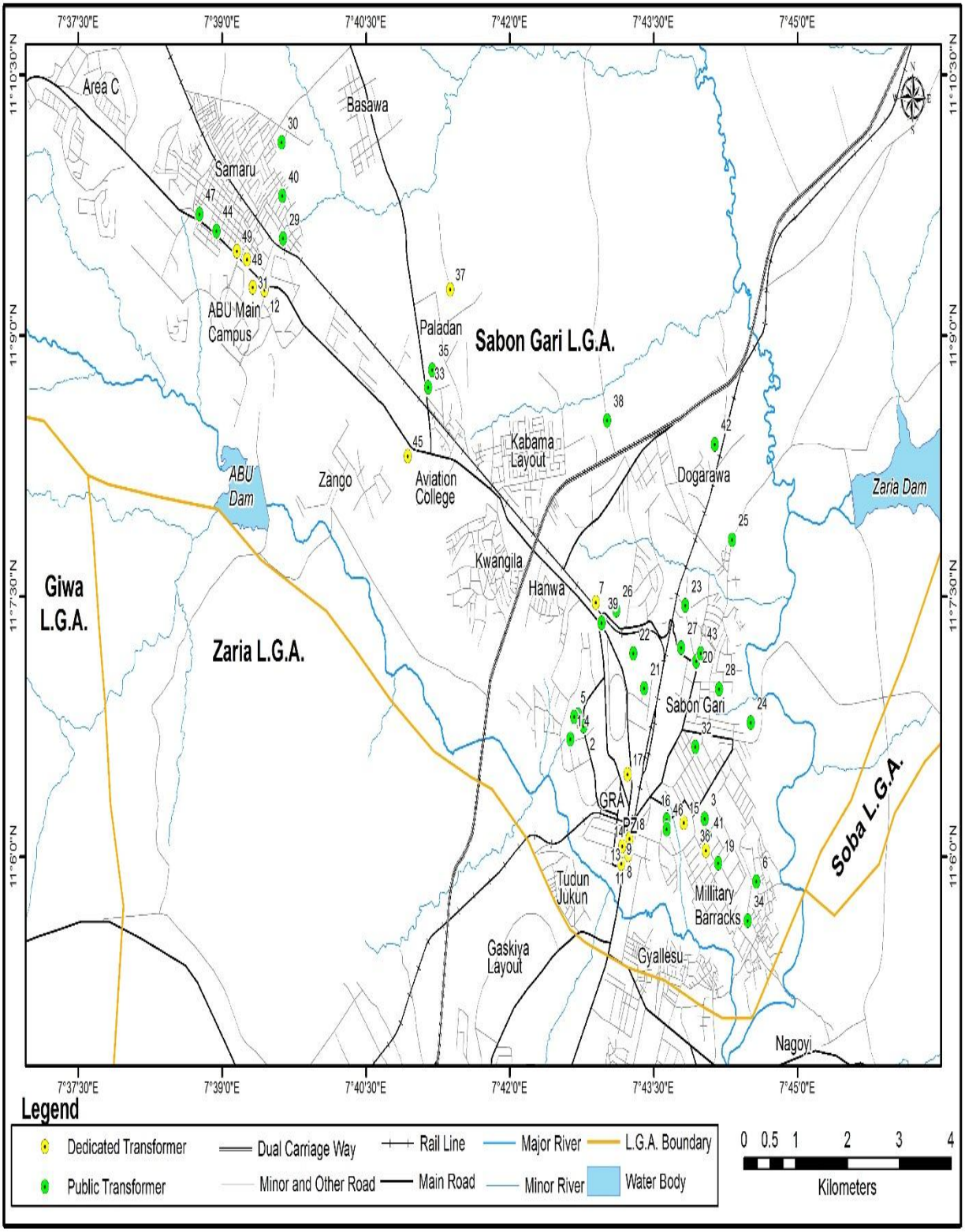


Figure 4.1: Zaria showing the location of Power Transformers in the study area

The map in fig 4.1 shows the locations of the transformers in the study area and each transformer is represented with a dot. The green dot represents the dedicated transformer while the yellow dot represents the public transformer. The areas that make use of the dedicated transformers are the industries, banks, Government Reserved Areas (GRA), higher institutions like A.B.U and Aviation College. These areas have few transformers and the transformers are managed by the organizations. While the areas that make use of the pubic transformers which is dotted yellow are the general public like Sabon Gari, Samaru areas etc these are the transformers that PHCN are in charge of. They are the ones that service and maintain the transformer. In these areas, the transformers are fewer than the population. The population is more due to the rate at which the areas are developing.From the map it shows that most of the transformers in the study area are located along the roadside and some are scattered in the area while some are clustered within a particular area. And most of the transformers have been at that spot for a very long time. Some are in good shape while some have even been condemned.

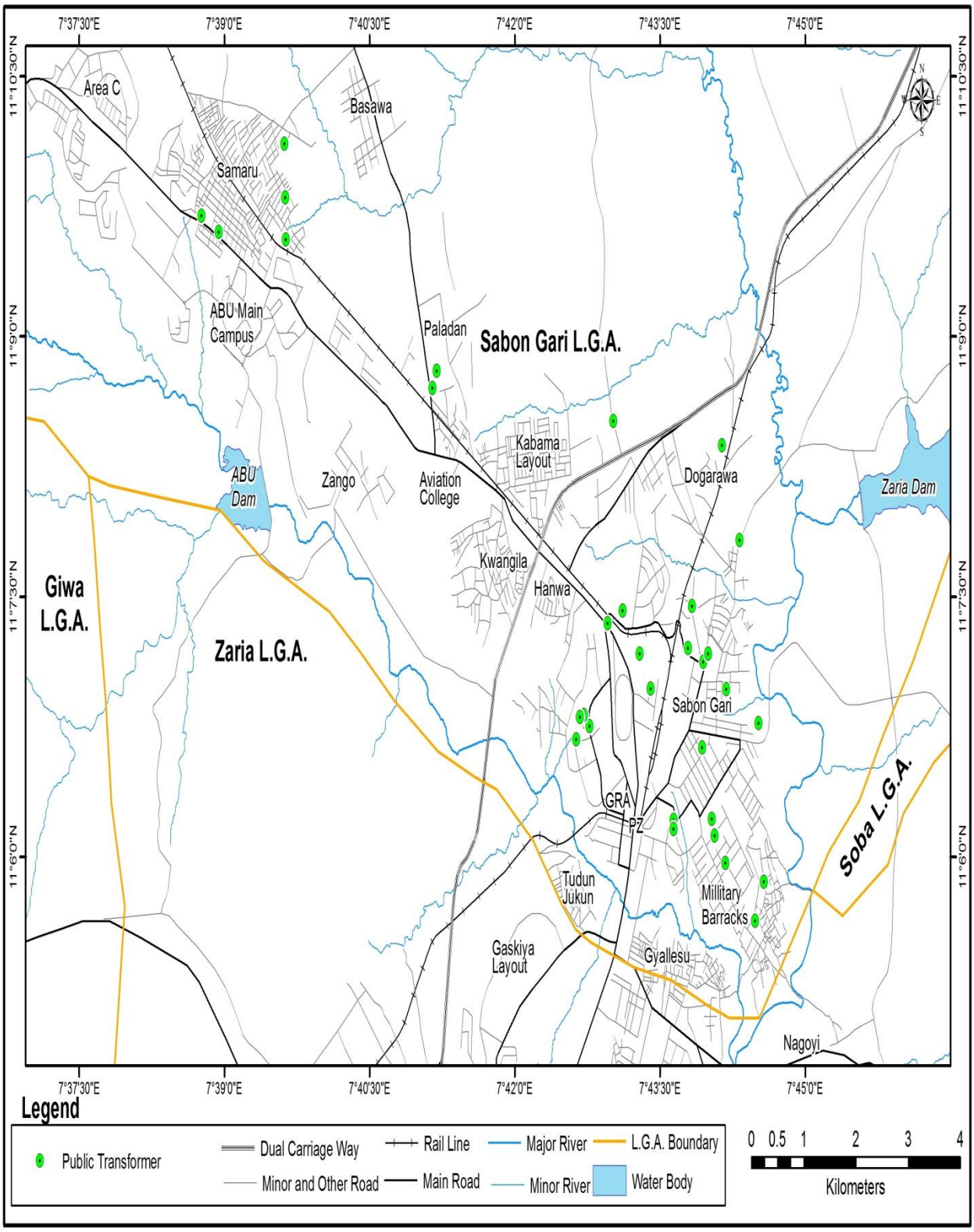


Figure 4.2 Zaria showing the location of Public Transformers in the study area

Figure 4.2 shows only the areas where the public transformers are used and they are represented with green dots. From the map it shows that some transformers have been fixed in

a linear form, some are scattered while few are clustered around the areas as a result of the fact that when the transformers where installed at that time the population was fewer unlike now that the population has highly increased and the transformers in those areas cannot really serve. The area where we have more transformers can be found in Sabon Gari where the population is higher due to the presence of the market.

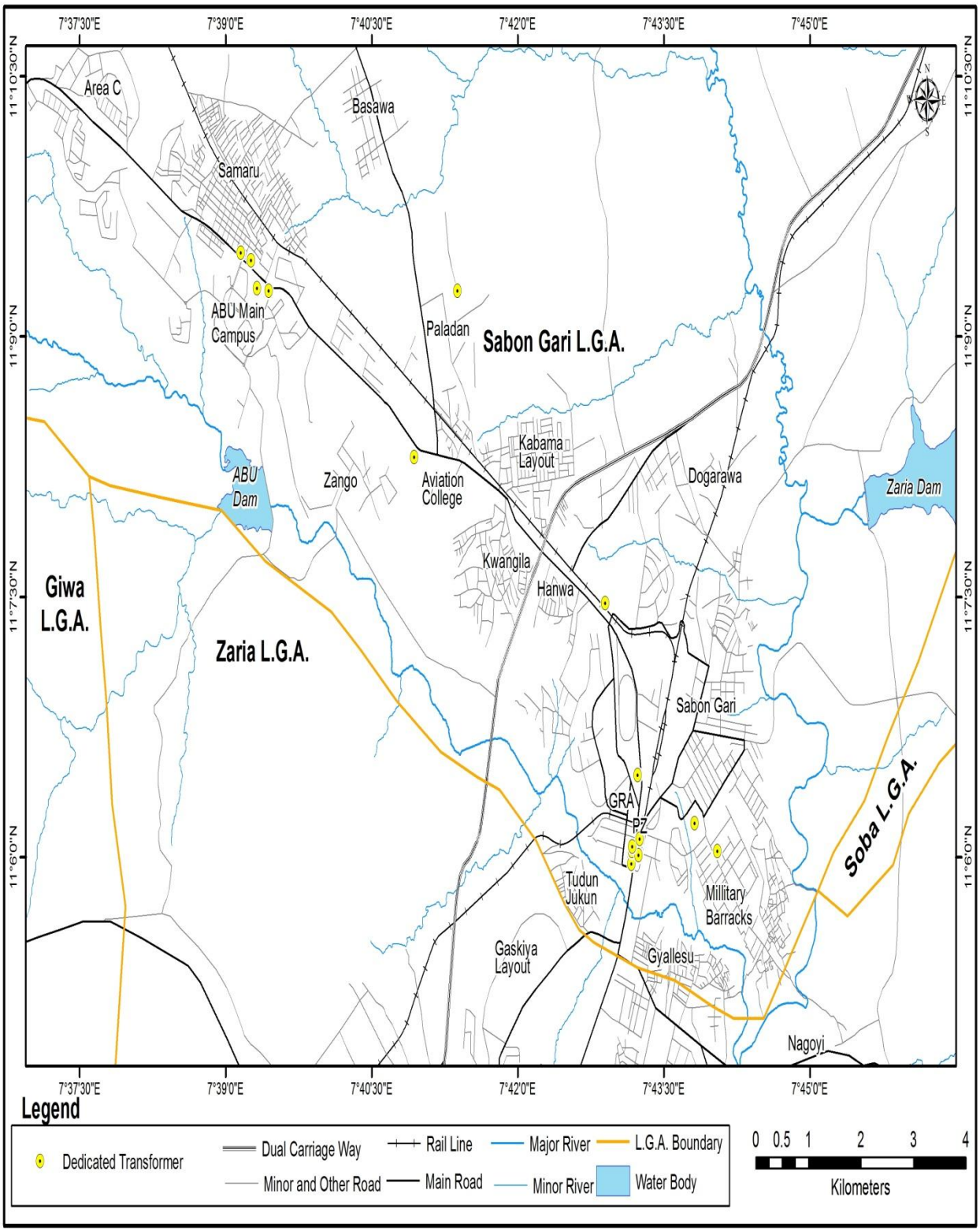


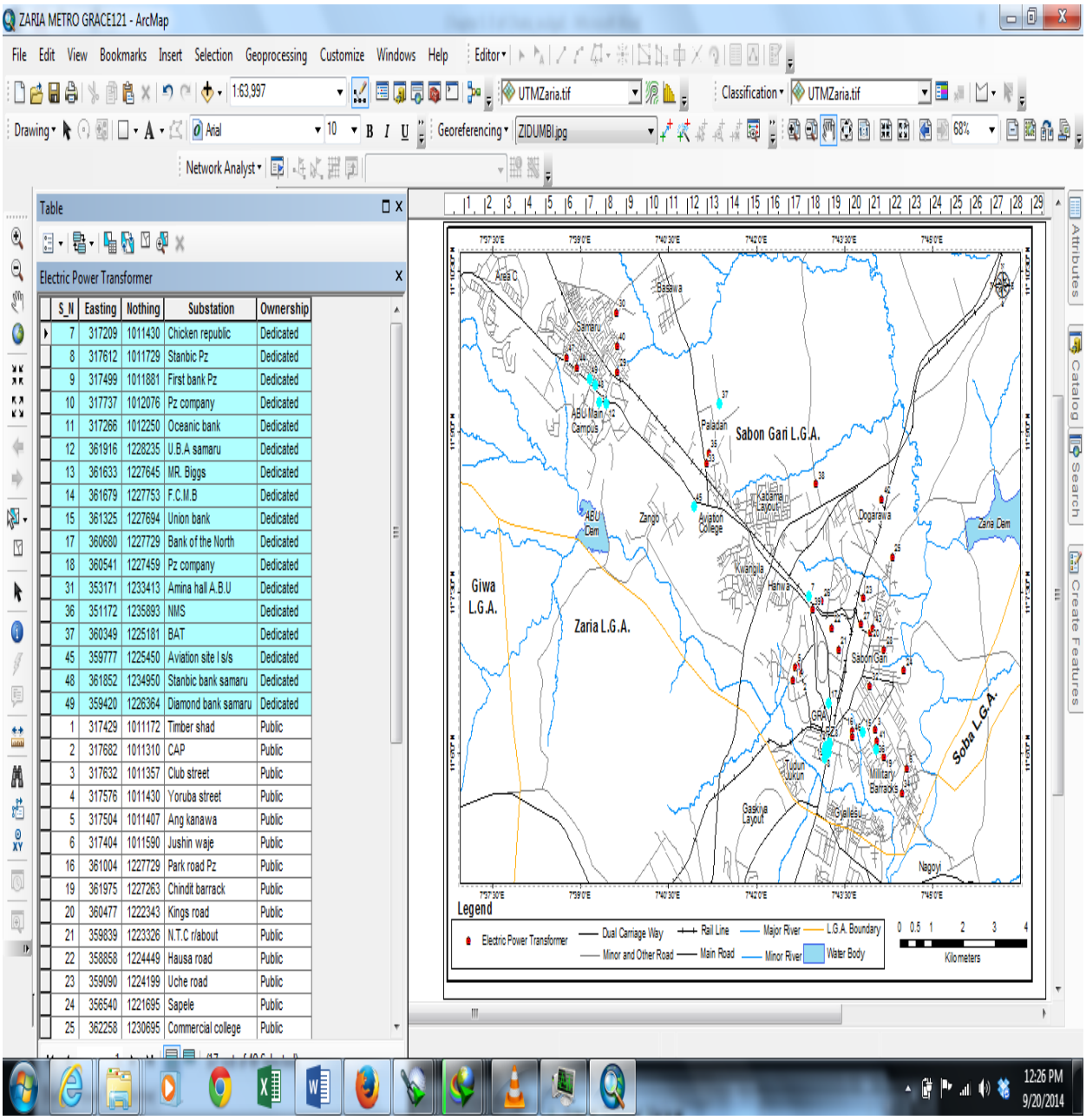
Figure 4.3: Zaria showing the location of Dedicated Transformers in the study area

The map in Fig 4.3 shows the areas that uses dedicated line because they use dedicated transformers. The dedicated transformers are represented with yellow dots. The transformers

on this map are very few because the transformers are mostly used by organizations such as banks, industries, universities like A.B.U etc. These transformers are not found everywhere they are usually fixed in a particular place in the premise that is why they are scattered as shown in the map and the only place where it is clustered is in PZ where there are many banks and eateries and they all make use of their own transformers. These transformers are being maintained and serviced by engineers that work in those places. Like in the case of A.B.U, the university has their own engineers and they work in the bulk metering section. They are the ones that handle the entire transformers in the university. These transformers last longer due to proper maintenance.

4.3 THE DATABASE OF TRANSFORMER

Figure 4.4showsa screen shot of the geospatial database of all transformers with dedicated and public transformers (respectively) selected in blue and the attribute table in the right hand side.



S_N	Easting	Nothing	Substation	Ownership
7	317209	1011430	Chicken republic	Dedicated
8	317612	1011729	Stanbic Pz	Dedicated
9	317499	1011881	First bank Pz	Dedicated
10	317737	1012076	Pz company	Dedicated
11	317266	1012250	Oceanic bank	Dedicated
12	361916	1228235	U.B.A samaru	Dedicated
13	361633	1227645	MR. Biggs	Dedicated
14	361679	1227753	F.C.M.B	Dedicated
15	361325	1227694	Union bank	Dedicated
17	360680	1227729	Bank of the North	Dedicated
18	360541	1227459	Pz company	Dedicated
31	353171	1233413	Amina hall A.B.U	Dedicated
36	351172	1235893	NMS	Dedicated
37	360349	1225181	BAT	Dedicated
45	359777	1225450	Aviation site I s/s	Dedicated
48	361852	1234950	Stanbic bank samaru	Dedicated
49	359420	1226364	Diamond bank samaru	Dedicated
1	317429	1011172	Timber shad	Public
2	317682	1011310	CAP	Public
3	317632	1011357	Club street	Public
4	317576	1011430	Yoruba street	Public
5	317504	1011407	Ang kanawa	Public
6	317404	1011590	Jushin waje	Public
16	361004	1227729	Park road Pz	Public
19	361975	1227263	Chindit barrack	Public
20	360477	1222343	Kings road	Public
21	359839	1223326	N.T.C r/about	Public
22	358858	1224449	Hausa road	Public
23	359090	1224199	Uche road	Public
24	356540	1221695	Sapele	Public
25	362258	1230695	Commercial college	Public

Figure 4.4: A Screenshot of the Spatial Database Electric Power Transformersin Study Area

In the screen shot of the spatial database of electricity power transformer which shows most of the transformers in the study area, both the dedicated and the public transformer are represented here. From the table, the part colored blue is the dedicated transformers while the part colored white are the public transformers.

4.4 Distribution of Electricity Transformers by PHCN Staff

Presentation in Table 4.1 shows that PZ unit has the highest percentage of transformer distribution with 38%, followed by Samaru unit with 35% and the least being Dogarawa unit with 27% of distribution transformers under the study area. In addition, both Samaru and Dogarawa distribution unit have more public owned transformer than PZ distribution unit in the study area. This indicates that both Samaru and Dogarawa distribution unit account for 40% each while PZ distribution unit has 20%. This indicates that Samaru and Dogarawa are more of residential than industrial while PZ has more of industrial and bank areas.

On the aspect of private owned transformer it shows that PZ distribution unit has more transformers than Samaru and Dogarawa distribution unit in the study area. This indicates that PZ distribution unit account for 56% while Samaru distribution unit accounts for 30% and Dogarawa distribution unit accounts for 14%.

Based on the frequency of the capacity of transformers, 100KVA is the lowest capacity of transformer in the study area while 500KVA is highest capacity of transformer in the study area. The frequency of 100KVA which is the lowest capacity is 50% is mostly found in the banks. This is because the banks have their own transformers and they don't share their transformers while that of 500KVA which is the highest capacity of transformer is 70%is mostly found in the residential areas because the transformers carry more houses than the 100KVA.

Table 4.1 Distribution on number of Public owned Transformers, Private owned Transformers, Lowest Capacity of the transformers, Highest Capacity of the transformers, Conditions of Public transformers and Conditions of Public transformers

Variables	Frequency	Percentage
Number of Transformer Under PHCN Units in Sabon Gari		
Samaru	35	35
Dogarawa	27	27
PZ	38	38
Total	**100**	**100**
Public owned Transformers		
Samaru	20	40
Dogarawa	20	40
PZ	10	20
Total	**50**	**100**
Private owned Transformers		
Samaru	15	30
Dogarawa	7	14
PZ	28	56
Total	**50**	**100**
Lowest Capacity Transformers		
50 KVA	20	40
100 KVA	25	50
200 KVA	5	10
Total	**50**	**100**
Highest Capacity Transformers		
300 KVA	15	30
500 KVA	35	70
1000KVA	0	0
Total	**50**	**100**
Conditions of Public Transformers		
Needs repair	40	80
Needs change	10	20
In good condition	0	0

Total	**50**	**100**
Conditions of Private Transformers		
Needs repair	0	0
Needs change	0	0
In good condition	50	100
Total	**50**	**100**

Source: Field Survey, 2015.

In addition, the condition of the transformer matters for effective distribution and utilization. Majority of the staff (80%) are of the opinion that the public transformers need repairs and about 20% also said the transformers need change. This is as a result of the load the transformers are carrying which makes the transformer to become overloaded and even breakdown. Suleiman and Ali (2009) attributed overloads and poor maintenance of transformers as factors responsible for a total breakdown of over 31 transformers with an estimated cost for repairs and replacements amounting up to 30 million naira in a related study carried out in Sokoto state Nigeria.

While on the aspect of the condition of the private transformers 100% of the staff, are of the opinion that the transformers are in good condition and this is because these transformers are owned by companies, banks etc and they do not carry much load so they last longer than the public transformers.

4.5 Utilization Level of the Electricity Transformers

Presentation in Table 4.2 shows that 100% of PHCN Staff are of the opinion that the public transformers are over loaded. This indicates that the level of illegal connections done on the public transformers is high and also the number of transformer are also few compare to the number of houses in the study area. While 80% of the PHCN Staff are of the opinion that the private transformers are moderately utilized and 20% are of the opinion that the private

transformers are under loaded utilized. This shows that the private transformers carry fewer loads and the number of houses, banks and companies that make use of these transformers are few compare to that of the public transformers. The maintenance culture is also very good because it is done by the engineers in companies and banks.

Table 4.2 Utilization Level of the Electricity Transformers based on PHCN Staff

Variables	Frequency	Percentage
Utilization Level of Public Transformer		
Over loaded	50	100
Moderately loaded	0	0
Under loaded	0	0
Total	**50**	**100**
Utilization Level of Private Transformer		
Over loaded	0	0
Moderately loaded	40	80
Under loaded	10	20
Total	**50**	**100**
Type of Transformer under load shading		
Public Transformer	50	100
Private Transformer	0	0
Total	**50**	**100**
Type of Repairs Done on Transformer		
Change of Fuse	35	70
Replacement of coils and core	10	20
Replacement of radiator, tanks	5	10
Others	0	0
Total	**50**	**100**

Source: Field Survey, 2015.

On the aspect of the transformers that load shading carried out on, 100% of the PHCN Staff indicated that load shading is done on the public transformers because the

transformers are usually overloaded due to the fact that the houses are more than the transformers and for every house to have electricity rationing of the light must be done and this is done in a way that an area will be given electricity for 6 hours and the other areas alike. Load shading cannot be done on the private transformers because their transformers are not overloaded.

Based on the type of repairs carried out on the transformers, 70% accounted for change of fuse, 20% accounted for replacement of coils and core while 10% accounted for replacement of radiator and tanks. This indicates that the changing of the fuse is mostly common because of either high voltage or overloading of the transformers this makes the fuse to burn and in the aspect of the replacement of coils, core, radiator and tanks it's not that common because it takes a longer time before they get damaged unlike the fuse.

4.6 Utilization Level of the Electricity Transformers by Respondents

The utilization level of the electricity transformers was determined by analyzing the administered questionnaires. A total of 361 respondents were interviewed out of which 361 questionnaires were retrieved and analyzed, giving a response rate of 100%.The results are shown on Tables 4.4 to 4.14.

4.6.1 Distribution of Respondents by Gender

Table 4.3shows the distribution of respondents by gender. It reveals that out of 100% respondents, 55.96% of the respondents are male while 44.04% of the respondents are female.

Table 4.3 Gender of Respondents

Sex	Frequency	Percentage
Male	202	55.96
Female	159	44.04

Total	**361**	**100.0**

Source: Field Survey 2014

From research it has been seen that men make use of electricity more than women especially the youths (male) who are more involved in business like barbing salon, welding, mechanic, fridge and television repairers, football houses where they always go to watch ball etc. they also engage in illegal connections on the electric poles which affects the transformers and as a result of this make the transformer overloaded and even get damaged. For example timber shed in Sabo market which usually gets burn as a result overloading of the transformer which is done through illegal connection of wire i.e. too many wires connected to one power line.

4.6.2 Distribution of Respondents by Age

Table 4.4 reveals the age distribution of the respondents. The majority of respondent with 28.25 are aged between of 31-40 years, followed by the age group of 41-50 years and 21-30 years with 23.83% and 22.71% respectively. Many of the respondent fall within the economically active age group of 21-50 years.

Table 4.4 Ages of Respondents

Age	Frequency	Percentage
< 20 years	32	8.86
20-30 years	82	22.71
31-40 years	102	28.25
41-50 years	86	23.83
> 50 years	59	16.34
Total	**361**	**100.0**

Source: Field Survey 2014

This category of respondents make use of electricity supply in their offices, workshop and for commercial and residential activities. The age group 50 and above has a percentage of 16.34%. It is obvious from Table 4.4that majority of the people are in the productive and reproductive age group that are most likely to utilize energy.

4.6.3 Distribution of Respondent by Occupation

Table 4.5 reveals that 20.50% of the respondents are public servant, 27.51% of the respondents are petty traders, and 29.36% are farmer while 22.99% are unemployed. About 77.01% of the respondents belong to one occupational group or the other where electricity is very essential for their daily activities.

Table 4.5 Occupation of Respondents

Occupation	Frequency	Percentage
Public servant	183	50.69
Petty trader	118	32.68
Farmer	20	5.54
Others	40	11.08
Total	361	100.0

Source: Field Survey 2014

Electricity is required by petty trader for their business operation. Farmers use it for irrigation, in the poultry farm and for food storage. The public servants require electricity in their offices for their electrical appliances to work. This reveals that there is high utilization of electricity in the area since virtually every occupational group requires electricity.

4.6.4 The Number of Electrical Appliance in your House

Table 4.6 reveals that 69.5% of the respondents reported that they have within 1-5 electrical appliances in their houses while 30.5% of the respondents also reported that they have within 6-9 electrical appliances in their houses.

Table 4.6: Number of Electrical Appliance

Number of electrical appliance	Frequency	Percentage
1-5	251	69.5
6-9	110	30.5
Total	**361**	**100.0**

Source: Field Survey 2014

Therefore, this Table shows that the population of the respondents with household appliances between 1-5 are more compare to those that have with 6-9 electrical appliances. This indicates that those who have less number of electrical appliance do not consume more electricity like those who have more electrical appliances.

4.6.5 Distribution of Electrical Appliances by the Type found in Houses

Table 4.7 reveals that 5.54% of the respondents have washing machine in their houses, 16.62% have pressing iron, 15.23% have television, 12.46% have blender, 2.77% use dish washer, 14.12% have radio set, 13.85% have rechargeable lamb, 11.08% have electric stove while 8.31% have electric oven in their houses.

Therefore, this shows that houses that have smaller electrical appliances like rechargeable lamb, pressing iron, radio and blender don't consume more electricity like houses that make use of all the above mentioned electrical appliances. Houses that have fewer electrical appliances do not usually exert much load on the transformers like those houses who have all the above mentioned electrical appliances.

Table 4:7 Types of Electrical Appliances

Types of Electrical Appliances	Frequency	Percentage
Washing machine	20	5.54
Pressing iron	60	16.62
Television	55	15.23
Blender	45	12.46
Dish washer	10	2.77
Radio	51	14.12
Rechargeable lamb	50	13.85
Electric stove	40	11.08
Electric oven	30	8.31
Total	**361**	**100.0**

Source: Field Survey 2014

In addition, houses which usually have more electrical appliances have effect on the transformer and this can make the transformer to be overloaded and mostly areas which usually have this challenge of overloading usually have their power supply rationed most of the time.

4.6.6 The Nature of Electric Power Supply in Sabon Gari

Table 4.8 reveals that 6.09% of the respondents reported that they have regular power supply in their area, while 93.91% of the respondents are of the opinion that they have irregular power supply in their area. If that be the case it can be reported that there is very poor supply of light to Sabon Gari L.G.A. This L.G.A is an urban settlement that has a lot of small scale

enterprise and such the power supply there is poor and the level of utilization is high and since the power supply is low the occupants are forced to make use of generators almost every day.

Table 4.8: Nature of Electric Power Supply

Nature of supply	Frequency	Percentage
Regular	22	6.09
Irregular	339	93.9
Total	**361**	1 **100.0**

Source: Field Survey 2014

Therefore, it is possible to conclude that the areas with regular supply of power are those areas which have dedicated transformers i.e. they manage their transformers themselves e.g. Banks, Universities, Companies etc. while areas with irregular power supply are those areas like Sabon Gari, some part of Samaru and Hanwa etc. the transformers in these areas are managed by PHCN the power supply in these areas are irregular due to illegal connection of wires which eventually leads to the breakdown of the transformer.

4.6.7 Number of Hours on Power Supply

Table 4.9 reveals that 2.22% of the respondents reported that they have 24 hours of power supply, while 67.31% and 21.61% reported that they have power supply for 12hours and 5hours respectively.

Table 4.9Distribution on Power Supplyby Hours

Power Supply Hours	Frequency	Percentage

24hrs	8	2.22
12hrs	243	67.31
5hrs	78	21.61
None of the above	32	8.86
Total	**361**	**100.0**

Source: Field Survey 2014

From research it has been found that respondents with power supply between 24hours and 12hours are those residents around the educational institutions like A.B.U, F.C.E to mention a few as a result of this, the people that reside in those areas always enjoy electricity more than those that stay outside those areas who get electricity for just 5hours. This is because these areas are under special distribution network and also use mostly private transformers.

4.6.8 Number of Houses with Generator

Table 4.10 reveals that 76.2% of the respondents reported they have generator in their houses while 23.8% of the respondents said they don't have generator in their houses.

Table 4.10: Houses with Generator

Houses with Generator	**Frequency**	**Percentage**
Yes	275	76.2
No	86	23.8
Total	**361**	**100.0**

Source: Field Survey 2015

From the Table, it is clear that due to power challenges in the study area most of the occupants make use of generators while just few don't have due to financial constrain and some areas usually have light like those around the company areas. This is caused by the high level of

illegal connection which is done on the wire which affects the transformer which also leads to rationing of light in the area.

4.6.9 Frequency of Generator Usage

Table 4.11 reveals that 33.2% of the respondents reported that they make use of their generator once a day, 55.7% of the respondents reported that they make use of their generator twice a day, while 11.1% of the respondents also reported that they always use their generator.

Table 4.11:Distribution on Frequency of Generator Usage

Use of Generator	Frequency	Percentage
nceOnce a day	120	33.2
Twice a day	201	55.7
Always	40	11.1
Total	**361**	**100.0**

Source: Field Survey 2015

Therefore, it can be concluded that those who use their generator once a day are people that stay in residential areas and they put on their generator mostly in the night after work due to the fact that they usually have light in the morning time and those who use their generator twice a day are areas like A.B.U, shops, welders workshop, salons, television and fridge repairers workshop and this is because electricity supply is not always constants but at least better than some few years ago when power supply was bad. While those areas which always use generator are areas like banks and companies because they need electricity for effective work in the companies and banks.

4.6.10 Number of Hours the Generator works

Table 4.12 reveals that 11.08 of the respondents use the generator for just 2hours, 29.36% of the respondents use it for 5hours, 42.94% use the generator for 10hours and 16.62%% of the respondents use the generator for 24hours. The hours the generator is been used depends on the availability of public electricity supply in the area.

Table 4.12: Distribution on Number of Hours Generator works

Hours the Generator works	Frequency	Percentage
2 hrs	40	11.08
5 hrs	106	29.36
10hrs	155	42.94
24 hrs	60	16.62
Total	**361**	**100.0**

Source: Field Survey 2015

Respondents using their generators between 10hours and 24hours are mostly companies, educational institutions and banks. They usually make use of generator so as to keep their business operations running especially when supplies from the public source are unstable or unavailable.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

Involvement of Kaduna Electricity Distribution Company (KEDCO) in the distribution and utilization of electricity transformers has emerged as a promising alternative to improve electricity at a more efficient and cost effective manner. The achievement of which is largely dependent on capacity of the PHCN Staff, population to be served, quality of electricity transformers and government policies regulating the distribution and utilization of electricity transformers.

The result of the Public owned transformers showthat 40% of the transformers can be found in both Samaru and Dogarawa area while the rest (20%) of public transformer is found in PZ area. Also the result of the private owned transformer shows that 30% of the transformers is found in Samaru area, 14% in Dogarawa and 56% which is more is found in PZ where there are more banks and companies.

In terms of the lowest capacity level of the transformer, 40.0% accounted for 50KVA, 50.0% accounted for 100KVA and 10.0% also accounted for 200KVA as the lowest capacity level of a transformer. While in the aspect of the transformer with the highest capacity level 30.0% accounted for 300KVA as the highest capacity, 70.0% accounted for 500KVA as the highest capacity level of transformers in the area.

On the aspect of conditions of public transformers, 80.0% of the staff are of the opinion that the transformers need repair while the rest (20.0%) are also of the opinion that the transformer needs change. While about 100% of the staff are of the opinion that the private transformers are in good condition in the area. Based on the frequency of the utilization level of public transformer, (100%) of the staff are of the opinion that the transformers are over loaded

and (80.0%) of the staff opined that the utilization level of the private transformers is moderately loaded while the rest (20.0%) also opined that the transformers is underutilized. (100%) of the PHCN staff indicated that load shading is mostly done on public transformers and not on private transformers. while about (70.0%) of the PHCN staff indicated that the type of repairs done on transformer is just only changing of the fuse, (20%) indicated that it is the replacement of coil and core while the rest (10.0%) also indicated that it is the replacement of radiator and tanks.

Furthermore, based on the socio economic characteristics of the resident respondents, the finding on gender distribution shows that males constitute the majority with 55.96%, while the females accounted for 44.04%; with the reason for the dominance of male being that they were more accessible and willing to give information as compared to the females. The age pattern of the respondents reveals that 8.86% of the respondents are less than 20 years and the highest percentage of respondent with 28.25% is in the age group of 31-40 years, followed by the age group of 41-50 years and 21-30 years with 23.83% and 22.71% respectively.

Distribution of respondents by Occupation indicated that Civil Servants constitute the highest proportion of respondents with 50.69%, followed by traders that represent 32.68%, followed by farmers that represent 5.54%. Findings on the number of electrical appliances in their homes the respondents indicates that the highest proportion that accounted for 69.5% have 1-5 electrical appliances in their homes, compared to 30.5% who have 6-9 electrical appliances in their homes. On the type of the electrical appliances, 5.54% of the respondents have washing machine in their houses, 16.62% have pressing iron, 15.23% have television, 12.46% have blender, 2.77% use dish washer, 14.12% have radio set, 13.85% have rechargeable lamb, 11.08% have electric stove while 8.31% have electric oven in their houses. Analysis on the nature of power supply from the residence shows that 6.09% of the respondents reported that they have

regular power supply in their area, while 93.91% of the respondents are of the opinion that they have irregular power supply in their area.

The result on the response of respondents on power supply hours show that most of the respondents (67.31%) reported that they have power supply for 12 hours, while only a few (2.22%) reported that they have power supply for 24 hours every day. In the aspect of house with generator 76.2% of the respondents reported they have generator in their houses while 23.8% of the respondents said they don't have generator in their houses.

To understand the rate at which the generator is been used, residents were asked to affirm the number of times in a day when they make use of their generators and it was found that majority 55.7% use it twice a day, 11.1% use it always while 33.2% use their generator once a day. On the number of hours the generator works, majority that comprises of 42.94% indicated that it works for 10hours and this has to do with the area, while the least proportion of respondents that make up 11.08% indicated that they use their generator for just 2hours and this is as a result of the present improvement of power supply in the area.

5.2 Conclusion

This study examined the spatial distribution and utilization of electricity transformer in SabonGari local government area in Kaduna state. The supply of adequate and stable electricity to consumers is the back bone of socio-economic growth of any nation and Nigeria is not an exception. The power sector in Nigeria has multidimensional problems such as bribery, corruption and mismanagement of funds for execution of electricity power projects. The overloading of transmission and distribution transformers, vandalizing of power lines by thieves, winds, construction projects, soil erosion etc, are not unconnected with power problems faced in Nigeria. These factors are seriously affecting the performance indices of electricity utilities in the country. The performance indices are efficiency, number of customers connected to distribution

line per transformer, high maintenance cost and transmission line losses (Copper losses). The loading of transmission and distribution transformer should be reduced. This is in order to trim down the number of customers per transformer. Illegal connection should be discouraged by the stakeholders. PHCN's management should develop a maintenance culture whereby they check on their equipments more regularly rather than waiting for the equipments to finally breakdown before they find a solution. The management of PHCN should also employ and train competent staff in order to be able to deal with the challenges of providing quality services to its numerous customers. And also they should be upgrading their equipments to be able to meet up with the demand of its customers. The Federal Government should also give PHCN more funds to enable them get more transformers and also monitor the buying and fixing of the transformers.

This research has found and concluded that GIS is a tool capable of mapping and building a geo database for all the transformers in Sabon Gari LGA. A digital map was produced to show the positions of each transformer with a textual data (attribute data) providing all the necessary information's about the transformer.

5.3 Recommendations

Based on the findings of this research, it is recommended that more transformers be provided in the study area in order to reduce the pressure on the existing ones. Moreover, servicing of transformers should be carried out regularly. It is further recommended that the result of this research be utilized by decision maker for sustainable development.

To improve the delivery of electricity to consumers in Nigeria the civil liberty organizations, the non-governmental organizations and ordinary citizens have to cooperate and work together for good maintenance culture, good governance since the government is not delivering well the dividends of democracy. To maintain adequate supply to the consumers in any part of the globe is a very challenging task, which requires dedication, political will, political

stability and above all faithfulness to God. For Nigerians to have adequate electricity supply this study recommends the following:

i. The loading of transmission and distribution transformers should be reduced. This is in order to trim down the number of consumers per transformer to a ratio of about 10 consumers per distribution transformer.
ii. Illegal connections should be discouraged by electricity power stakeholders.
iii. More effort must be made to bring in refined and scientific approaches such as Geographic Information Systems into the management of electricity distribution network.
iv. Training programs should be organised for technical online staff on electricity distribution on the integration of GIS in the management/ monitoring of electricity distribution.
v. Establishment of more distribution substation transformers in low voltage area within the study area.

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DEPARTMENT OF GEOGRAPHY

AHMADU BELLO UNIVERSITY, ZARIA

Dear Respondent,

I am a student of the above department. This questionnaire is design to collect information for an Msc Research on the "SPATIAL DISTRIBUTION AND UTILIZATION OF ELECTRICITY TRANSFORMERS IN SABON GARI LOCAL GOVERNMENT AREA, KADUNA STATE". This exercise is purely academic and so any information supplied would be used strictly for that purpose and thus treated as confidential.

SECTION A

1. Sex (a) Male [ ] (b) Female [ ]
2. Marital status: (a) Single [ ] (b) Married [ ] (c) Divorced [ ]

3. Age: (a) Less than 20 years [ ] (b) 21-30 years [ ] (c) 31-40 years [ ] (d) 41-50 years [ ] (e) 50 and above [ ]
4. Occupation (a) Civil servant [ ] (b) Petty trade [ ] (c) Farmer [ ] (d) Others specify
5. Educational attainment (a) Primary [ ] (b) Secondary [ ] (c) Tertiary [ ] (d) None [ ]
6. How many years have you lived in this area? (a) 5-10 [ ] (b) 11-20 [ ] (c) 21 and above [ ]
7. How many electrical appliances do you have in your house? (a) 1-5 [ ] (b) 6-9 [ ]
8. Which of these electrical appliances do you have in your house?

   (a) washing machine [ ]
   (b) pressing iron [ ]
   (c) television [ ]
   (d) blender [ ]
   (e) dish washer [ ]
   (f) radio [ ]
   (g) rechargeable lamb[ ]
   (h) electric stove [ ]
   (i) electric oven [ ]

9. Do you have generator in your house? (a) Yes [ ] (b) No [ ]
10. How often do you make use of it? (a) Once a day [ ] (b) Twice a day[ ] (c)
11. How many hours does it work? (a) 5 hours[ ] (b) 2 hours[ ] (c) 10 hours[ ] (d) 24hours[ ]
12. How much do you pay on average monthly on electricity bill a. below ₦1000 ( ) b. ₦1,500 – ₦2000 ( ) c. ₦2,500 – ₦3,000 ( ) d. ₦3,500 and above ( )
13. How populated is your area? a. Densely populated [ ] b. Sparsely populated [ ] c. Moderately populated [ ]
14. Do you have transformer in your locality? (a) Yes [ ] (b) No [ ]
15. What type of transformer serves your resident? a. Dedicated transformer [ ] b. Public transformer [ ]

16. How far is your house from the transformer? a. Close [ ] b. Far [ ] c. Very far [ ]
17. Does the distance affect power supply? (a) Yes [ ] (b) No [ ]
18. Has the transformer been changed or serviced before? (a) Yes [ ] (b) No [ ]
19. If yes when? _____
20. How often do you experience transformer related power outage?a. Daily [ ] b. Twice weekly [ ] c. Monthly [ ] d. Others specify [ ]
21. How is the supply nature? a. Regular [ ] b. Irregular [ ]
22. How many hours do you enjoy power supply?a. 24 hours [ ] b. 12 hours [ ] c. 5 hours [ ] d. None of the above [ ]
23. Are there illegal connection done on your transformer? (a) Yes [ ] (b) No [ ]
24. Does the illegal connection have any effect on the transformer? (a) Yes [ ] (b) No [ ]
25. To what extent is the transformer been used? a. Under loaded [ ] b. Averagely loaded [ ] c. Over loaded [ ]
26. Do you think the transformer in your locality serve your community effectively? (a) Yes [] (b) No [ ]
27. How do you think this transformer can be optimally utilized?

_____

_____

_____

_____

PHCN STAFF CHECKLIST

DEPARTMENT OF GEOGRAPHY

AHMADU BELLO UNIVERSITY, ZARIA

Dear Respondent,

I am a student of the above department. This questionnaire is design to collect information for an Msc Research on the "SPATIAL DISTRIBUTION AND UTILIZATION OF ELECTRICITY TRANSFORMERS IN SABON GARI LOCAL GOVERNMENT AREA, KADUNA STATE". This exercise is purely academic and so any information supplied would be used strictly for that purpose and thus treated as confidential.

1. Office location _____

2. Positions _____

3. Number of electric transformers under the unit _____

4. Number of customers connected under the unit _____

5. Number of public owned transformer _____

6. Number of private owned transformer _____

7. What is the lowest capacity of transformers in your unit _____

8. What is the highest capacity of transformers in your unit _____

9. What is the condition of most public transformers? (a) need repair (b) needs change (c) in good condition

10. What is the condition of most private transformers? (a) need repair (b) needs change (c) in good condition

11. What is the utilization level of the public transformer? (a) over loaded (b) moderately loaded (c) under loaded

12. What is the utilization level of the private transformer? (a) over loaded (b) moderately loaded (c) under loaded

13. Do you shade transformer load in your unit? Yes or No

14. What type of transformer is load shading done on? (a) Public transformer (b) Private transformer

15. How frequently do you carry out transformer repairs?

16. What type of repair do you mostly do? _____ (a) Change of fuse (b) Replacement of coils and core (c) Replacement of radiator, tank (d) others

17. Please kindly give recommendations and suggestions you may consider useful to the quality of power supply in your unit.

Appendix1: Database Report of Sabon Gari Electricity Transformers

S/N	Shape	TransId	Easting	Nothing	Substation	
1	Point	T1	317429	1011172	Timber shad	
2	Point	T2	317682	1011310	CAP	
3	Point	T3	317632	1011357	Club street	
4	Point	T4	317576	1011430	Yoruba street	
5	P	T	3	1	Angka	

	oint	5	17504	011407	nawa	
6	P oint	T 6	3 17404	1 011590	Jushin waje	
7	P oint	T 7	3 17209	1 011430	Chick en republic	
8	P oint	T 8	3 17612	1 011729	Stanbi cPz	
9	P oint	T 9	3 17499	1 011881	First bank Pz	
10	P oint	T 10	3 17737	1 012076	Pz company	
11	P oint	T 11	3 17266	1 012250	Ocean ic bank	
12	P oint	T 12	3 61916	1 228235	U.B.A samara	
13	P oint	T 13	3 61633	1 227645	MR. Biggs	
14	P oint	T 14	3 61679	1 227753	F.C.M .B	
15	P oint	T 15	3 61325	1 227694	Union bank	
16	P oint	T 16	3 61004	1 227729	Park road Pz	
17	P oint	T 17	3 60680	1 227729	Bank of the North	
18	P oint	T 18	3 60541	1 227459	Pz company	
19	P oint	T 19	3 61975	1 227263	Chind it barrack	
20	P oint	T 20	3 60477	1 222343	Kings road	
21	P oint	T 21	3 59839	1 223326	N.T.C r/about	
22	P oint	T 22	3 58858	1 224449	Hausa road	
23	P oint	T 23	3 59090	1 224199	Uche road	
24	P oint	T 24	3 56540	1 221695	Sapele	
25	P oint	T 25	3 62258	1 230695	Com mercial college	
26	P oint	T 26	3 62229	1 230579	Muchi a	
27	P oint	T 27	3 60593	1 229853	Chikaj i	
	P	T	3	1	Amin	

8	oint	28	62004	229111	urd s/s 1	
9	Point	T 29	3 53628	1 233822	Hayin danyaro	
0	Point	T 30	3 53723	1 234947	Hayin dogo	
1	Point	T 31	3 53171	1 233413	Amin a hall A.B.U	
2	Point	T 32	3 55753	1 231730	Benin street	
3	Point	T 33	3 56495	1 232335	Maim una s/s	
4	Point	T 34	3 59981	1 227305	Jushin waje	
5	Point	T 35	3 56572	1 232521	Ang mall sule	
6	Point	T 36	3 51172	1 235893	NMS	
7	Point	T 37	3 60349	1 225181	BAT	
8	Point	T 38	3 60247	1 225309	Yantu kwane	
9	Point	T 39	3 53557	1 234820	MTD junction	
0	Point	T 40	3 54464	1 224725	Dogo nyaro	
1	Point	T 41	3 61777	1 227557	Leven tis s/s	
2	Point	T 42	3 61821	1 232492	Hayin ojo 1	
3	Point	T 43	3 61660	1 229492	Hayin ojo 11	
4	Point	T 44	3 58121	1 220158	Samar u market	
5	Point	T 45	3 59777	1 225450	Aviati on site I s/s	
6	Point	T 46	3 61003	1 227629	Zagi-zage s/s	
7	Point	T 47	3 57406	1 224297	Dogo niche	
8	Point	T 48	3 61852	1 234950	Stanbi c bank samaru	
9	Point	T 49	3 59420	1 226364	Diam ond bank samaru	

Source: Field Survey, 2014.